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# Groundwater Management Strategy for Michigan
# Hydrogeologic Study Handbook

Michigan Dept. of Natural Resources
Lansing

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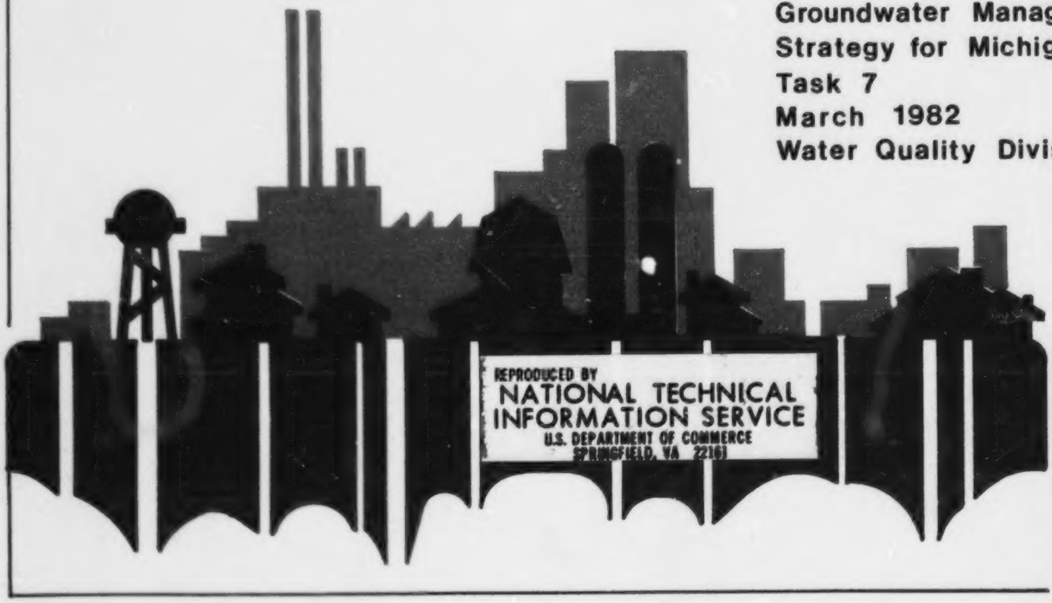
# Hydrogeologic Study Handbook

Groundwater Management
Strategy for Michigan
Task 7
March 1982
Water Quality Division



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The goal of the Hydrogeologic Study Handbook is to provide assistance to the people of the State of Michigan in the planning and conducting of hydrogeologic studies and groundwater quality monitoring. Those minimum elements that should be discussed in all study plans and hydrogeologic investigations are detailed in the Hydrogeologic Study Plan and Report of Hydrogeologic Investigation sections.

Hydrogeologic studies vary in scope and complexity depending on the purpose(s) of the investigation. The types of information that specific State agencies may request in a study are outlined in the section entitled Specific Types of Hydrogeologic Studies.

Because monitoring programs are essential to most hydrogeologic studies, the handbook contains a Groundwater Monitoring section. This segment was designed to aid in the planning, construction, design and use of monitoring wells as well as in the establishment of monitoring systems. Procedures for collection, preservation, custody and analysis of soil and water samples are also outlined.

The field of hydrogeologic investigation is expanding rapidly in Michigan, as well as throughout the Nation. It is hoped that the Hydrogeologic Study Handbook will aid in the groundwater professional as well as the layman in understanding the purpose, and mechanics of conducting proper hydrogeologic studies.

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# HANDBOOK

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# TABLE OF CONTENTS

Page

Introduction . . . . . i

## CHAPTER 1 - ELEMENTS OF HYDROGEOLOGIC STUDIES

Purpose of a Hydrogeologic Investigation . . . . . 1
Hydrogeologic Study Plan . . . . . 2
Responsibility and Procedures for Submission of a Hydrogeologic Investigation . . . . . 5
Report of Hydrogeologic Investigation . . . . . 6
Specific Types of Hydrogeological Studies . . . . . 8
  Known and Suspected Groundwater Contamination . . . . . 9
  Land Disposal and Application of Wastewater . . . . . 11
  Development of Public Water Supplies . . . . . 14
  Hazardous Waste Facilities . . . . . 21
  Landfills . . . . . 22

## CHAPTER 2 - HYDROGEOLOGIC STUDY AND MONITORING METHODS

Purpose . . . . . 30
System Design . . . . . 30
Number and Location of Wells . . . . . 31
Cross Contamination Prevention During Drilling . . . . . 37
Observation Well and Monitor Well Construction . . . . . 38
Developing Monitor Wells . . . . . 39
Protection of Wells . . . . . 39
Reporting Requirements . . . . . 40
Monitor Well and Test Hole Abandonment . . . . . 41
Soil Sampling Procedures . . . . . 41
Analyzing Soil Samples . . . . . 42
Water Sampling . . . . . 43
After Well Construction . . . . . 43
Cross Contamination Prevention . . . . . 46
Monitoring Parameters . . . . . 47

APPENDIX 1: Part 22. Groundwater Quality Rules, Promulgated Pursuant to Water Resources Commission Act 245, P.A. 1929 . . . 53
  Part 8. Groundwater Sources Rules, Promulgated Pursuant to Safe Drinking Water Act 399, P.A. 1976 . . . 61
  Part 4. Disposal Facility Construction Permits and Standards, Promulgated Pursuant to Hazardous Waste Management Act 64, P.A. 1979 . . . 69
  Part 3. Sanitary Landfills, Promulgated Pursuant to Solid Waste Management Act 641, P.A. 1978 . . . 89

APPENDIX 2: Programs Under Which Hydrogeological Studies Are Required or Prepared . . . 105

# INTRODUCTION

Numerous State programs require hydrogeologic investigations to determine the impacts of proposed or existing activities on our water resources. However, it has not always been clear to those that must conduct the studies what should be included in a hydrogeologic investigation submitted to the State. The Part 22 Rules of the Water Resources Commission (Act 245, P.A. 1929, as amended) provided some direction on the elements to be included in such investigations. However, these rules apply specifically to groundwater discharge permits and are not broad enough in scope to provide direction for all hydrogeologic investigations. The purpose of this handbook is to describe the purpose and elements of various types of hydrogeologic studies and groundwater quality monitoring.

Chapter 1, "Elements of Hydrogeologic Studies" identifies those minimum elements that should be discussed in all study plans and hydrogeologic investigations and further describes the additional types of information that certain State agencies may request in specific types of studies.

Monitoring programs are essential to most hydrogeologic studies. Therefore, Chapter 2, entitled "Hydrogeologic Study and Monitoring Methods", is designed to aid in the planning, construction, design and use of monitoring wells as well as in the establishment of monitoring systems. Procedures for collection, preservation, custody and analysis of soil and water samples are also outlined.

The Appendices include descriptions of the various State programs that require hydrogeologic investigations and copies of pertinent administrative rules.

The field of hydrogeologic investigation is expanding rapidly. It is hoped that this handbook will aid the groundwater professional as well as the layman in understanding the purpose, and mechanics of conducting hydrogeologic studies.

# CHAPTER I
# ELEMENTS OF HYDROGEOLOGIC STUDIES

## PURPOSE FOR HYDROGEOLOGIC INVESTIGATIONS

Hydrogeologic investigations are generally intended to accomplish one or more of the following objectives:

I. Determine whether a site will function properly for an intended use.

II. Determine what has been, is, or will be the impact of a previous existing or proposed activity on the water resources of the state.

III. Provide a basis for permit and monitoring requirements

IV. Provide a basis for facility design or site cleanup programs.

This handbook is intended to provide an outline that, if followed, should result in a report containing the appropriate elements of a hydrogeologic study. However, such studies will vary significantly in scope and complexity depending on the objectives for the study and the site conditions. Therefore, the person responsible for designing the study should fully understand the specific purpose for the investigation.

## HYDROGEOLOGIC STUDY PLAN

Submission of a hydrogeologic study plan for review and approval by the appropriate State agency is recommended before the hydrogeologic investigation is conducted.*

PROPOSED HYDROGEOLOGIC STUDY PLANS SHOULD INCLUDE THE FOLLOWING ELEMENTS IF APPROPRIATE TO THE STUDY:

### I. Statement of Reason for Hydrogeologic Investigation

A. This should include an outline of the existing or proposed activities at the site. Outline what resources are being impacted or need to be protected and what is to be determined by the study.

B. The investigation of hydrogeologic conditions should cover sufficient geographic area to allow for a definition of the probable impact of the proposed or existing activity on the groundwaters and surface waters of the State.

### II. Location of Map and Site Plan

A. Location map: Use appropriate maps to show location of site. A county map base and/or a topographic map to ¼, ¼ section is preferred. Locate site and proposed or existing activity in relation to existing land uses, highways, and roads, county and township lines, sections, surface water courses and wells (e.g., water wells and oil and gas wells). The map should also include data points utilized in the study plan. Aerial photos, if used, should be supplemental.

B. Site plan: An appropriately scaled plan should include property lines, buildings, location of existing and proposed activities, borings, wells, sample points, drains, ditches, lakes, ponds, springs, and swamps, surface water drainage and monitor wells, existing data points utilized in making preliminary evaluation, and location of any other activities (e.g., spills) that may impact groundwater quality or affect usability of the site for proposed or existing activities.

### III. Collection and Review of Available Data on Study Area

State possible conclusions about study area derived from available data. The study plan should reference, footnote, cite or copy and attach all pertinent data supporting the conclusions drawn. The data to be reviewed should include the following types of information sources.

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*Emergency spill situations will occur with the potential for detrimental impact on the groundwaters of the state. In such situations, submission of a study plan prior to conducting any immediate drilling or recovery operations may result in unacceptable delays in action. However, with use of the handbook for direction, and/or consultation with appropriate Department of Natural Resources staff, most emergency actions could be conducted in an acceptable manner and time frame. Additional hydrogeologic studies may be necessary to determine the full impacts of emergency situations after remedial action is completed.

A. water well records
B. existing geologic reports in area
C. soil and topographic maps
D. aerial photos
E. previous hydrogeologic studies in area
F. groundwater quality data
G. surface water quality data
H. processes at site (mfg., waste streams, hydrogeologic)
I. characterization of waste
J. expected discharge parameters
K. past and present waste hauling and disposal practices
L. water supply source and usage amounts
M. characterization of site from previous studies--foundation borings, soil studies, etc.
N. location of water usage in area e.g. irrigation wells and water supplies
O. climatological data
P. stream flow data
Q. geophysical information
R. land use studies

A reference of available groundwater information has been compiled by the DNR. This reference entitled "Resource Definition" cites types of groundwater information presently available and where the information can be obtained. The reference is available from the National Technical Information Service, Springfield, VA, 22161. Please ask for "Resource Definition" Task 4, Groundwater Management Strategy for Michigan, NTIS Number PB82 143884.

## IV. Outline for Further Work

Outline the additional data needed to fulfill the purpose of the investigation. Describe how the data is to be obtained.

A. Identify (on maps drawn to scale) proposed locations and depths for the following activities:

1. observation well* installation (a minimum of 3 for determination of horizontal groundwater gradient, more are usually needed)
2. monitor well** installation
3. soil borings

* Observation well means a well that is specifically designed to determine existing hydrogeological conditions.

** Monitoring well means a well that is specifically designed to measure the impact of a discharge on the groundwaters.

B. Describe the procedures and equipment that will be used for each of the above activities. Construction method, materials, sampling intervals and techniques should all be clearly defined.

C. State the procedures and equipment to be used for soil and water quality data collection and analysis. Describe sampling depths, sampling method, parameters to be sampled for, type of equipment used to collect the sample, preservation methods for samples, method of analysis and detection limits for parameters. Indicate the laboratory(ies) that will be analyzing the collected samples.

D. Outline soil tests to be performed (e.g., porosity, permeability, grain size, sieve analysis, mineralogical classification, cation exchange, moisture content, density, Atterburg limits).

E. Outline quality assurance methods that will be used in drilling, construction, sampling, and avoidance of cross-contamination of samples or aquifers (drilling methods, construction techniques).

F. Identify the permit (Act 315) or license (Act 368) granting you authority to drill. Outline the plugging methods or program to be used.

G. Establish a time schedule for the study. Provide specific target dates. In some cases it is desirable to conduct a study in phases. (For example, in groundwater contamination studies, a phase I study may determine the direction of groundwater flow. Phase II may then address placement of monitor wells. It often takes several phases to outline the extent of contamination. A study plan and approval is recommended for each phase.)

## V. Changes in Study Plan

It is recognized that situations will arise that may necessitate major changes or adjustments from the original study plan. In order to avoid extra time and cost that may be incurred by unacceptable changes, it is strongly suggested that significant changes be discussed with the reviewing State agency, at earliest convenience, either verbally or in writing.

## RESPONSIBILITY AND PROCEDURES FOR SUBMISSION OF A HYDROGEOLOGIC INVESTIGATION

**I. As required by the acts referenced in Appendix 2, the person responsible for the proposed or existing activity will be responsible for the submission of a hydrogeological investigation.**

**II. Submit the hydrogeological investigation to the appropriate State agency for review and comment.**

**III. The State will review the hydrogeologic investigation and give written comments, instructions, or approval.**

## REPORT OF HYDROGEOLOGIC INVESTIGATION

### I. State the Reason for Investigation

Describe the existing and proposed activities at the site. Identify the resources to be protected and the objective of the study.

### II. Location of Investigation

The hydrogeologic investigation-location, land use and site plan maps should be revised and updated from the study plan maps that have been submitted earlier, if necessary.

A. Location map: Use appropriate maps to show location of site. A county map base and/or a topographic map to ¼, ¼ section is preferred. Locate site and proposed or existing activity in relation to existing land uses, highways, and roads, county and township lines, sections, surface water courses and wells (e.g., water, oil and gas, etc.). The map should also include data points utilized in the study plan. Aerial photos, if used, should be supplemental.

B. Site plan: An appropriately scaled plan should include property lines; buildings; location of existing and proposed activities, borings, wells, sample points, site activities, drains, ditches, lakes, ponds, springs and wetlands, surface water drainage, and monitor wells; pre-existing data points utilized in making brief evaluation; and location of any other activities that may impact the groundwater or affect usability of site for proposed or existing use(s).

### III. Conclusions

Summarize conclusions that address the objectives of the study and briefly state the major theory that most adequately explains the functional aspects of the hydrogeology at the site. Summarize information pertinent to the support of this theory. Describe the existing and potential impacts of this activity on the human and natural environment.

### IV. Recommendations

State recommended actions and alternatives for any additional work needed (e.g., further hydrogeologic study, engineering modifications, possible remedial clean-up actions, or project modifications).

### V. Data Presentation

Present all data, to allow the reader to evaluate the validity of your conclusions. Provide information outlined in Part IV of the Hydrogeologic Study Plan Section (Outline for Further Work) and explain any deviations from the approved study plan.

## VI. Data Analysis and Interpretation

A. Explain the rationale for your choice of conclusions, including detailed analysis of supportive and non-supportive data and methods employed. Included should be:

1. Alternative conclusions
2. Assumptions made
3. References of methods, equations and calculations used and limits of their application.

B. If modeling is used in the analysis:

1. Discuss the basic assumptions made and the applicability of the model to the site
2. Outline the initial and boundary conditions used in the simulation
3. State the mathematical equation being solved
4. Reference or supply the documentation of the program used
5. Discuss the model calibration, and any sensitivity analysis of model parameters or boundary conditions.

## SPECIFIC TYPES OF HYDROGEOLOGIC STUDIES

Groundwater studies are most often associated with:

Known and Suspected Groundwater Contamination
Land Application of Wastewater
Development of Public Water Supplies
Hazardous Waste Facilities
Landfills

This section outlines specific information pertinent to the above listed types of studies. Also included are the names and addresses of the State agencies that site specific information and questions should be referred to.

## Known and Suspected Groundwater Contamination

Groundwater studies are often required at sites of known or suspected groundwater contamination such as discharges that have been documented to have violated permit limitations, unpermitted discharges or accidental spills to the groundwater.

### Purpose

These studies have the following purpose:

A. To assess the existing and potential impacts that the contaminants may have on usable aquifers, water supply wells, and surface waters.

B. To determine the need for remedial action.

C. To provide the data necessary for design of corrective measures, where such action is required.

Hydrogeological studies are expected to be of sufficient scope to provide sound data on which to make proper resource management decisions. Limited scope studies may be appropriate when trying to establish whether the groundwater has been contaminated.

### Study Plan

Each study should be preceded by a study plan to be reviewed by Water Quality Division staff and others in the Michigan Department of Natural Resources. Studies that are undertaken without an approved study plan, risk incurring additional cost, time, and hydrogeologic study requirements.

### Study Design

A. Hydrogeological studies submitted should be designed to define the hydrology of the study area including at a minimum:

  1. Determining the vertical and horizontal extent of contamination.
  2. Determining where contaminants are going and what controls the flow.
  3. Existence, continuity, and slope of any aquitards and aquifers.
  4. Direction of groundwater movement and rate of flow.
  5. Nature and behavior of contaminants.
  6. Potential or existing impact of contaminants on usable aquifers, water supply wells, and surface waters.

Questions or correspondence concerning known or suspected groundwater contamination should be directed to:

Groundwater Quality Section
Water Quality Division
8th floor Stevens T. Mason Building
P.O. Box 30028
Lansing, Michigan 48909

Telephone: (517) 373-8147

Questions or correspondence concerning known or suspected groundwater contamination that may be associated with oil and gas exploration and production should be directed to:

Groundwater Geology Unit
Geological Survey Division
4th floor Stevens T. Mason Building
P.O. Box 30028
Lansing, Michigan 48909

Telephone: (517) 373-7860

## Land Application of Wastewater

### Purpose

The purpose of a land application facility is to use a plant/soil system to treat wastewater so that groundwater degradation (Rule 323.2202(g) of Part 22 of Act 245 of P.A. 1929) does not occur. The purpose of a hydrogeologic study for this kind of facility is, in addition to those purposes stated on page 3, to locate a site suitable for land application and determine the hydrogeologic characteristics of the site. A land application facility can then be designed to treat wastewater to levels that will not degrade groundwater in usable aquifers and/or surface waters.

Under the requirements found in Sections 10 and 11 of Act 98 of P.A. of 1913, as amended and the Part 22 Rules of Act 245 of P.A. of 1929, as amended, hydrogeologic and crop system studies should be done for all wastewater lagoons and land application systems. Hydrogeologic and crop system studies for land application projects (those facilities which discharge effluent to the ground via seepage cells, flood, irrigation, or spray irrigation) should contain the additional information outlined below:

### Additional Data Collection

I. The expected quality of wastewater effluent to be applied to the land should be discussed.

   A. This discussion should outline the nutrient value of the wastewater i.e., concentration of nitrogen (as $NO_3$-N, $NO_2$-N, $NH_3$-N and organic nitrogen), phosphorus, potassium and plant micronutrients.

   B. The pollutants in the wastewater should also be discussed. These would be materials that are hazardous or toxic to humans, animals, or plants. Specifically metals, complex organic substances, and methylene blue active substances are considered pollutants.*

   C. The general chemistry of the wastewater effluent should be given. This includes the parameters listed in R323.2207, 9diii of the Groundwater Quality Rules. (They are Ca, Na, Mg, Cl, $SO_4$, and $HCO_3$).

II. The nutrient/pollutant uptake capacity of the plant/soil system should be detailed and supporting data and calculations submitted.

III. Pertinent climatological data should be given e.g. the length of growing season, precipitation, evaporation and evapotranspiration data for the area and/or crop(s) being studied.

* Lists of critical materials used by various industries served by a specific municipality can be obtained from the Office of Toxic Materials Control, P.O. Box 30028, Lansing, MI 48909. Requests should be made by municipality, for the Critical Materials Register Master Program.

IV. Included as part of the evaluation should be a description of possible irrigation equipment, the amount of land needed, application rates and possible crops that could be grown for each method evaluated.

**Data Analysis**

I. The ability of the plant/soil system to treat wastewater should be analyzed.

II. The possibility of groundwater mounding should be evaluated. The method used to calculate potential mounding and the limits and assumptions associated with the method should be identified.

III. Determination of the proposed application rate should be discussed. Following are some of the factors used in the determination: on-site soils, including saturated and unsaturated permeability and water holding capacity; the water and nutrient uptake capacity of the plants; the soils ability to treat pollutants; expected groundwater mounding and sensitivity of the plants to wet conditions.

IV. The length of irrigation season and number of application days should be calculated. Time for planting, cultivating and harvesting the crop should be provided as well as time for repairing and maintaining the irrigation equipment and not irrigating during extremely wet conditions.

V. The amount of land necessary to treat the design flow of wastewater effluent at the proposed rate for the proposed irrigation season should be determined.

VI. A crop management plan should be developed for the proposed system. The following should be included in the plan:

A. The type of crop to be grown on the site.

B. The growing season for those crops.

C. The harvesting schedule and number of harvests per irrigation season for the crops.

D. A discussion of what will be done with the harvested crop.

**Contacts**

Comments or questions regarding land application of municipal wastewater should be directed to:

Municipal Design Review Section
Water Quality Division
Department of Natural Resources
P.O. Box 30028
Lansing, MI 48909

Telephone: 517-373-3710

**Comments or questions regarding land application of industrial and commercial wastewater should be directed to:**

**Permits Section**
**Water Quality Division**
**Department of Natural Resources**
**P.O. Box 30028**
**Lansing, MI 48909**

**Telephone: 517-373-8088**

## Development of Public Water Supplies

The Michigan Department of Public Health has responsibility under Act 399, P.A. 1976, to regulate, supervise, and control public water supplies. Appendix I includes the Part 8. Ground Water Sources Rules of Act 399 (Private water supplies are regulated by Part 127, Public Health Code, Act 368, P.A. 1978).

I. Details for studies of hydrogeologic conditions can be found in Rule 813 of Act 399 P.A. 1976. A study of hydrogeologic conditions in considering a well or well field for a Type I or IIa water supply may include information from existing wells or a test well, and should include the tasks listed below.

   A. Collection of drilling samples from test wells at 5' intervals and pronounced changes in formations;

   B. Drawdown information at pumping rates which equal or exceed the existing or proposed yield for 24 hours or until stabilized drawdown has continued for at least six hours when test pumped at 1.5 times the design pumping rate.

      1. Drawdown in two or more observation wells located at proper distances from the well being pumped;

      2. The drawdown or static water level should be related to any possible interference to or from other existing wells in the area.

   C. Field or laboratory determinations of physical and chemical constituents as may be required;

   D. History of abandoned wells in the area and method of plugging, if any;

   E. Included in the report should be the following information:

      1. Test pump capacity-head characteristics;

      2. Static water level;

      3. Depth of test pump setting;

4. Time of starting and ending each test cycle;

5. Recordings and graphic evaluation of the following: pumping rate, pumping water level, drawdown, water recovery rate and levels. (NOTE: Not sufficient at beginning and end only. See Section C, Paragraph 6-b for schedule of water level readings).

II. Performance testing requirements are detailed in Rule 830 of Act 399, P.A. 1976. MDPH criteria for yield testing suggests the following information for Type I and IIa supplies:

A. Time of test:

Test should be run after well has been constructed, developed, cleaned, and the depth accurately measured. All pumping and performance tests should be conducted in a manner as approved in the specifications and consistent with MDPH criteria.

B. Maximum capacity test pump:

1. The maximum capacity of the test pump should be equal to the maximum quantity of water that the well is expected to produce.

2. Overpumping may be advisable during a test pump to determine the presence of sand, provided the design screen entrance velocity is not exceeded.

C. Auxiliary equipment:

1. Access to the well should be provided for an electric dropline or steel tape and/or air line, complete with gauge, hand pump, and check valve, to measure the water level in the well.

2. The air line shall be securely fastened to the pumping unit and should terminate approximately at the maximum desired pumping level, but in no case should the air line be closer than two feet to the end of the suction pipe.

D. Disposal of water:

1. The water pumped from a well may be discharged directly onto the surface of the ground immediately adjacent to the well in some cases.

2. Care must be taken to avoid damage to surrounding property or structures.

3. When the well being tested is shallow and only a limited layer of impervious material lies between the water-yielding stratum and the surface of the ground, the water should be conducted and discharged to the nearest body of open water or to a point at least 300 feet (91 meters) from the well.

E. Duration of test - three phases of aquifer performance test:

1. Rest period - water levels in wells are closely observed to determine if any outside influences are causing changes, and if so, how much change.

2. Pumpage period - observations are made to determine how the water levels behave as the pumpage continues.

3. Recovery period - well is shut down and recovery rate is recorded in the pumped well and all observation wells.

Note #1 The length of the pump test depends entirely on local geologic conditions, but in general should last from 12 to 72 hours. In artesian formations a minimum of 24 hours is recommended and in water table aquifers, 72 hours is recommended, especially where the final desired well capacity approaches the limiting capacity of the well.

Note #2 All sand, and other foreign matter which may have been drawn into the well should be removed after the pump test.

F. Water level measurements should be recorded according to the following schedule:

1. Rest period should be at least one-quarter as long as the actual pumpage period. At least 5 uniformly spaced water level measurements should be taken in all wells, one just prior to starting the pump.

2. The measurements for the pumpage period should be recorded for the specified pumping duration using the following schedule:

(a) Every 2 minutes for the first 10 minutes;
(b) Every 5 minutes for the next 20 minutes;
(c) Every 10 minutes for the next 30 minutes;
(d) Every 15 minutes for the next 1 hour;
(e) Every 30 minutes for the next 2 hours;
(f) Hourly thereafter.

3. The recovery period generally only needs to be one-third as long as the pumpage period. However, the same schedule of water level measurement should be followed until recovery is complete and a straight line condition is shown in a semi-log graph.

4. Hourly measurements of nearby lake and stream levels should be recorded throughout the test period, and are more important for water table then for artesian conditions.

G. Factors influencing test duration:

1. Local experience - where wells have been operated nearby and in the same formation, and where water-yielding quantities of similar wells are well known, the test period can be shortened. However, if it is desired to note the effect of a new well on adjacent wells, the test period should not be shortened.

2. Intermittent pumping - if the well is to be pumped for only a limited period each day, and is allowed to fully recover to its normal level, the test period can be shortened.

3. Limited draft - if the permanent pump capacity is to be much smaller than the demonstrated output of the well at the start of the test, the test period can be shortened.

4. Season of the year - where the areas of water-bearing formations or tributary watersheds are small, the test period should be extended during wet seasons and shortened during dry seasons.

5. Water level - extreme care and judgment should be used in directing and interpreting the test. The important part of the test is the yield after the water level in the well has become practically stabilized, not while it is dropping. It is recommended that

in most cases the test pump be run until the water level in the well is stabilized while pumping at a constant rate, and that once this point is reached, the test be continued for several hours to make sure conditions do not change.

6. Determination of aquifer performance vs. individual well performance - a pump test conducted as an aquifer performance test should be conducted for a period of sufficient duration to obtain satisfactory data for evaluation by available analytical methods. A pump test in a water table aquifer will require a longer pumping period than in an artesian aquifer.

**H. Observation wells:**

1. Observation wells, where necessary, should be installed to determine the hydraulic properties of the aquifer being tested. A minimum of two wells located within the influence of the pumped well are needed when evaluating a water table aquifer.

2. The number of observation wells needed when evaluating an artesian aquifer depends upon the complexity of the test, size of the well field, desired reliability of the determinations, and other factors. Spacing from the pumped well should be established on a logarithm of distance.

3. Each observation well should be terminated at the same depth and in the same aquifer as the pumped well and should be tested to be sure the screen is open and is responding to changes in water levels prior to starting the test.

**I. Maximum drawdown:**

1. The maximum drawdown during the test should be less than five feet above the highest perforation on the screen or most productive formation in the bedrock.

2. If the pumping well or wells are deep and the above criteria would involve pumping against a greater head than economically feasible, the maximum allowable drawdown should be stated in terms of distance below the surface.

J. Aborted tests:

1. Water table conditions - a breakdown during the first hour of pumping requires that the aquifer be rested for one hour prior to restarting the test. Water level measurements should be taken during the down period. Breakdowns after the first hour should not exceed 5 minutes for each hour of pumping. If a non-pumping period exceeds 30 minutes, the test should be rescheduled.

2. Artesian conditions - breakdowns should not exceed 5 minutes during the first 3 hours of pumping or more than a 10 minute period during the remainder of the test.

K. Records and reports:

The consultant should submit to the department accurate written reports regarding water levels, pumping rates, and other pertinent details on construction of the production wells and all observation wells necessary in the evaluation of the aquifer characteristics and prior to permanent pump approval. An evaluation of the test results for Type I and IIa supplies should be submitted to the department prior to permanent pump approval.

III. Test pumping Type IIb and III public supplies:

A. Each Type IIb and III public water supply should be tested for yield and drawdown according to the following procedures or by a method approved by the department:

1. Be performed on every production well after construction or following treatment and prior to installation of the permanent pump.

2. Have a test pump capacity at maximum anticipated drawdown.

3. Provide for continuous pumping until stabilized drawdown occurs when test pumped at 1.5 times the design pumping rate.

B. Record the following data:

1. Test pump capacity;

2. Static water level;

3. Depth of pump setting during test;

4. Time of starting and ending each test cycle.

C. Provide the following information at regular intervals (see section C, 6-b for schedule of water level readings) as may be required by the department:

1. Pumping rate;

2. Pumping water level;

3. Drawdown;

4. Water recovery rate and levels.

D. Each Type IIb or III water supply should be test pumped at a rate equal or greater than 2.5 gallons per minute per living unit (or equivalent), but not less than 10 gallons per minute with a stabilized drawdown level in the well, or as agreed upon with the department.

Note #3 A copy of Act 399, P.A. 1976, and criteria may be obtained from the MDPH. Further questions or correspondence relating to the public water supply should be directed to the following offices:

Lower Peninsula

Water Supply Division
Michigan Dept. of Public Health
3500 N. Logan Street
P.O. Box 30035
Lansing, Michigan 48909

Upper Peninsula

Northern Peninsula Division
Michigan Dept. of Public Health
305 Ludington Street
Escanaba, Michigan 49829

## Hazardous Waste Facilities

Hydrogeologic studies required for licensing of hazardous waste facilities must be consistent with Part 22 Administrative Rules of the Water Resources Commission. (The term hazardous waste facility includes incinerators, landfills, treatment storage and disposal facilities.) Specific requirements for environmental monitoring, post closure maintenance and monitoring and landfill standards can be found in the Part 4 rules of act 64, P.A. 1979, a copy of which is included in Appendix I.

Direct further questions or correspondence concerning hazardous waste disposal facilities to the following section:

Hazardous Waste Management Section
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, MI 48909

## Landfills

The Resource Recovery Division acting under Act 64 P.A. 1979, Act 641 P.A. 1978 and P.L. 94-580 (RCRA) has the responsibility for evaluation, approval, monitoring and regulation of solid waste disposal systems. A copy of Part 3 of the Act 641, P.A. 1978, rules has been included in Appendix I. Application for disposal area construction must be accompanied by a determination of existing hydrogeological conditions specified in a hydrogeologic report and monitoring program.

### I. Hydrogeologic Study Proposed Work Plan

A work plan should be submitted to the Resource Recovery Division for review and approval. The work plan should follow the outline given in the REPORT OF HYDROGEOLOGIC INVESTIGATION section with the following additional elements included:

A. Legal description of site location.

B. Statement of purpose and objectives of a hydrogeologic investigation:

1. Determine site suitability.
2. Make recommendations for a monitoring program.

C. Proposed plan for conducting investigation:

1. Procedures for obtaining data and samples.
2. Soil sample classification and analyses.
3. Required permits necessary for investigation.

E. Time schedule for completion of proposed procedures.

### II. Preliminary Hydrogelogical Report

Upon submission of the preliminary hydrogeological report, the Resource Recovery Division will render a tentative opinion of the suitability of the property for use as a solid waste disposal site. An unfavorable report does not imply that the site cannot be engineered to remove, correct, or modify the limitations. Review will also assess a monitoring program recommendation and determine if additional soil borings, observation wells, mechanical analyses, or geophysical work are necessary.

The preliminary hydrogeological report should include the following background and supporting data:

A. Background information - on a copy of the most recent USGS topographical map of the area which contains the site (7.5 min. quad. if published), plot the information detailed in the HYDROGEOLOGICAL STUDY PLAN section of the handbook within one mile in all directions of the site boundaries.

The report should also include the limits of any 100 year flood plain (contact the Water Management Division, Department of Natural Resources, Box 30028, Lansing, MI 48909).

B. Type and Extent of Subsurface Materials

1. Natural Site - Investigations should be divided into two phases:

   (a) Phase I should consist of drilling sufficient soil borings to characterize the geologic setting of the proposed landfilling operation. Each soil boring should be designed to accomplish the following objectives:

      (1) Reach a depth that is equal to fifty feet below the bottom elevation of the proposed trench(es).

      (2) Permit soil sample collection with splitspoon, Shelby Tube, etc. equipment at the following, or lesser depths:

         (a) Every 10 feet to the elevation of the bottom of the trench.
         (b) Every 5 feet for the next 15 feet.
         (c) Every 10 feet thereafter and at the bottom of the boring.

      (3) Evaluate soil samples that are representative of the types of soils encountered in each boring according to the following tests:

         (a) Moisture content
         (b) Permeability
         (c) Size gradation (sieve and/or hydrometer tests)
         (d) Atterberg limits

   (b) Phase II, based on a review of the results in Phase I, will address the need for additional soil borings, mechanical analyses, or geophysical work. If applicable, the design for the groundwater monitoring system should be submitted at this time; otherwise, a plan for surface water monitoring should be developed.

If no aquifer is encountered and clay is continuous over the entire site area, a system of monitoring wells will not be required. If fifty feet of continuous clay is not encountered, a minimum of three observation wells should be installed regardless of depth of the aquifer (to determine groundwater flow direction and aquifer thickness).

2. Engineered Site* - Investigations should be divided into two phases:

   (a) Phase I will consist of sufficient soil borings to characterize the geologic setting of the landfill area drilled to twenty feet below proposed trench bottoms. Incorporated into this drilling can be the installation of the observation wells necessary to determine groundwater flow direction and thickness of the usable aquifer. If the soils on-site are to be used as liner/dike materials, a composite sample from each soil boring should be subject to the following mechanical analyses:

      (i) Verify unified soil classification of SC, ML, CL, or CH.
      (ii) Size gradation (sieve and hydrometer).
      (iii) Moisture-density relationship (modified proctor).
      (iv) Determine compaction necessary within the moisture range of +5% to -2% of optimum to achieve permeability of $1.0 \times 10^{-7}$ cm/sec.
      (v) Field moisture content.

   (b) Phase II will address the need for possible additional soil borings, geophysical work, etc. The design for the groundwater monitoring system should be submitted at this time.

C. Hydrogeology

1. The hydrogeology of the site will dictate its ultimate suitability and the final design of the facility. The design and operation will incorporate one or more of the following hydrogeologic principles:

   (a) Utilization of the existing natural environment to "treat" the leachate.

   (b) Modification of the natural environment to provide the desired hydrogeologic characteristics to either contain the leachate within the refuse or to provide attenuation in the resulting hydrologic flow system.

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* An engineered site has a liner constructed of natural material (e.g. clay) or artificial material (e.g. PVC).

(c) Isolation of the refuse from the surrounding flow system by the use of a natural or artificially installed liner and thence collecting and treating the leachate by an engineered system.

2. Data collected from soil borings, observation wells, geophysical surveys, water analyses, and other available pertinent information will establish the following necessary items:

   (a) Determine subsurface soils and bedrock, their distribution, thickness, and characteristics.

   (b) Determine static water levels and direction of groundwater flow.

   (c) Define aquifer(s), interconnections, vertical isolation.

   (d) Ground and surface water quality.

   (e) Recommendation for design of effective monitoring program.

* It should be noted that regardless of minimum requirements, the degree of subsurface information obtained must be sufficiently comprehensive to allow the consultant to make a detailed evaluation of the hydrologic and geologic properties of the subsurface materials, both at the site and laterally extrapolated, such that a reasonable estimate of the effects of these materials on the containment, migration, and attenuation of the leachate can be made.

## III. Landfill Monitoring Objectives

A ground and surface water monitoring program must be designed to accomplish the following objectives:

A. Demonstrate the presence or absence of leachate contamination.

B. Evaluate the effectiveness of precautionary or remedial measures (i.e., grading, cover, drainage systems, & other measures) at closed sites.

C. Perform scientific investigations in developing and validating rates of leachate movement, attenuation, dispersion, or dilution.

D. Collect evidential data for enforcement purposes.

E. Evaluate aquifer purging systems.

F. Confirm judgments made during facility design.

These objectives are to be accomplished by a continuing, long term, in-depth, hydrogeologic study regarding changes in the existing surface and groundwater conditions (chemistry or elevations) through a specific observation and monitor well system.

## IV. Landfill Monitor System Requirements

Surface and groundwater monitoring systems must be established to detect any influence of the solid waste disposal facility on the surface and groundwater resources. A minimum observation/monitoring system will contain three observation wells (piezometer) and three monitoring wells. Observation and monitor wells may be separate wells or combined into a single well. Monitor wells may not be necessary if certain geologic conditions exist. Surface water may be monitored instead of or in addition to monitor wells. Single well dual purpose installations will be permitted only if the well is constructed to meet the requirments for a monitor well and is located to conform to monitoring needs.

A minimum groundwater monitoring system will provide one well upgradient from the facility to establish background control for water quality evaluations and additional wells in a line perpendicular to the direction of groundwater flow downstream of the landfill, spaced at intervals no greater than 300 feet apart and installed at or near the solid waste boundary.

More specific information on monitor well design and sampling can be found in the GROUNDWATER MONITORING section.

## V. Landfill Monitoring Procedures

A. Water Level Measurement:

B. Water Sampling:

1. Samples of the groundwater should be obtained by the landfill operator or his consultant and submitted to a testing laboratory.

2. Samples will be handled and stored according to the quality assurance standards recommended by the testing laboratory.

3. Samples should be obtained as soon as a representative sample can be obtained after the well has been completed.

4. Subsequent sampling and water level measurements will be on a quarterly basis (the frequency of the sampling

may be altered by DNR personnel based on the results of the previous monitoring).

5. The DNR will split samples on an annual basis. More frequent splittings may be required if discrepancies arise.

Comments and questions regarding solid waste disposal sites should be directed to:

Resource Recovery Division
Westland Mall - 3800 W. Saginaw
Lansing, MI 48917

Telephone: (517) 373-0540

# CHAPTER II

# HYDROGEOLOGIC STUDY AND MONITORING METHODS

## GROUNDWATER MONITORING*

### Purpose

This chapter has been established to identify the basic hydrogeologic monitoring principles that should be considered when designing a groundwater monitoring program. While these recommendations are intended to be generally applicable, it is emphasized that site specific conditions may, in many cases, dictate the specific methods that are most applicable.

As well as being an integral part of hydrogeologic studies, monitoring is a management tool that is used to observe and control environmental changes. More specifically, monitoring is used to accomplish the following objectives:

1. Evaluate environmental impact
2. Determine the degree of attenuation of contaminants
3. Provide data for developing a predictive capability on contaminant migration
4. Determine the effectiveness and integrity of a waste disposal system.
5. Provide an early-warning monitor of adverse environmental changes
6. Provide a legal tool for:
    a. the enforcement of anti-pollution regulations,
    b. the activation of a contingency plan

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### System Design

Hydrogeologic investigations of proposed waste disposal sites are often required for the purpose of obtaining meaningful data on the distribution and characteristics of aquifers and aquitards and to define groundwater flow systems. Frequently, however, wells drilled to define the hydrogeologic framework of a site are subsequently the only wells used to serve as the monitoring system, even though they may be mislocated or inadequately constructed for the purpose of monitoring. While in many cases hydrogeologic test wells may serve as monitor wells, proper design procedure usually requires at least a two-phase program:

1. Establishment of observation wells to define the hydrogeologic framework; and
2. Installation of monitor wells, designed to measure the impact of a discharge on the groundwater, in locations specific to site conditions interpreted from the observation well data.

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* Portions after "Recommended Procedures for Landfill Monitoring Program Design and Implementation" proceedings of an International Seminar - Environmental Protection Service, Canada Report EPS 4-EC-77-3.

An effective monitoring system for any potential source of groundwater contamination should be capable of detecting and evaluating existing or potential contamination by periodically measuring both the extent and rate of lateral and vertical contamination migration from the source and the degree and nature of this contamination.

When designing a monitor system, all available information relating to groundwater quality and quantity in proximity to the specific site should be collected prior to drilling observation wells. Information gained through this initial search may provide basic knowledge upon which a monitoring program may be initially designed. Such information may be available through the Michigan Geological Survey, the U.S. Geological Survey, local and State Health Departments or other private, local, state, and federal agencies.

Design of a monitor system to meet specific hydrogeologic conditions must consider the following site parameters:

a. Geological soil and rock formations existing at the specific site.
b. Depth to and thickness of aquifers and relatively impervious layers.
c. Direction of groundwater flow and anticipated velocity.
d. Seasonal groundwater variations in quality and quantity.
e. Potential mounding of groundwater.
f. Distance from the source.
g. Location of nearby streams, lakes and swamps.
h. Location of potable and nonpotable water supply wells.
i. Other appropriate data to the specific system design.

Clearly, wells are the primary means of monitoring groundwater quality. But, other techniques can be used either separately or in conjunction with wells for monitoring groundwater. Supplemental systems such as geophysical surveys are useful tools to define contaminant plumes at some sites. For example, where subsurface geologic conditions are suitable for its use, resistivity surveys may provide assistance in the placement of monitor wells, by determining the subsurface geology and the lateral extent of groundwater contamination.

## Number and Location of Wells

### Observation Wells*

A triangulation of wells installed within the same hydrogeologic unit (see Figure 1) is necessary to define the horizontal component of flow.

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*Kevin McCray, "A Well Drilling Methods Primer", Water Well Journal, p. 45-47, November 1981

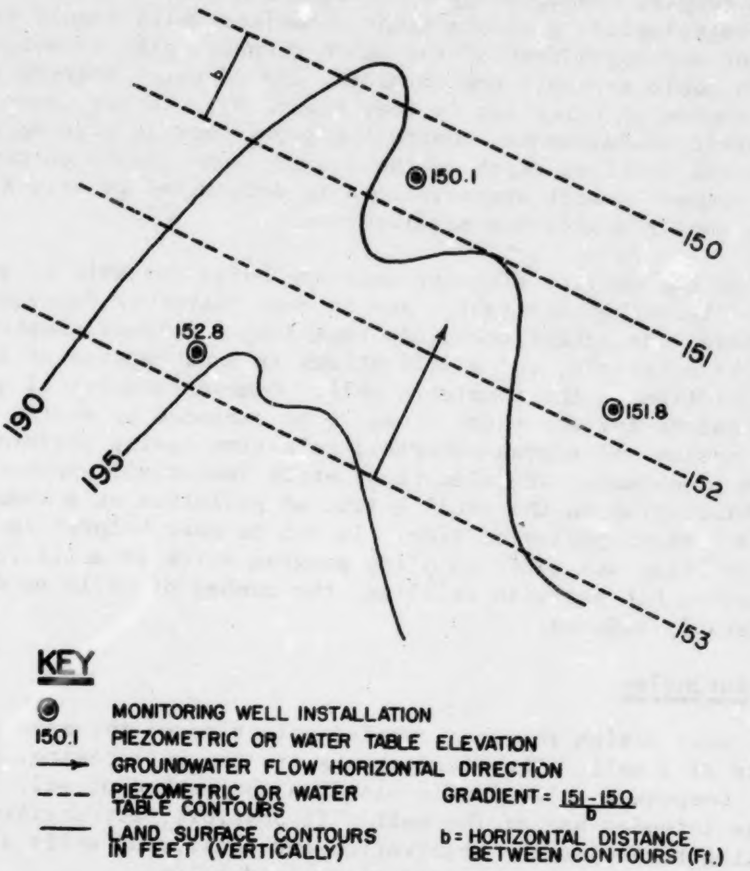

b
150.1
150
152.8
151
151.8
190
195
152
153
KEY
MONITORING WELL INSTALLATION
150.1 PIEZOMETRIC OR WATER TABLE ELEVATION
GROUNDWATER FLOW HORIZONTAL DIRECTION
PIEZOMETRIC OR WATER TABLE CONTOURS
LAND SURFACE CONTOURS IN FEET (VERTICALLY)
GRADIENT = 151-150 / b
b = HORIZONTAL DISTANCE BETWEEN CONTOURS (Ft.)

**FIGURE 1:** MONITORING WELL TRIANGULATION

(after Mooij and Rovers, 1975)

Therefore a minimum of three observation well installations are necessary to describe the general direction of groundwater flow in a simple hydrogeologic setting, in the absence of other site specific information. Additional wells may be required in order to measure the vertical component of flow. (See Figure 2).

## Monitor Wells

The number of monitor wells required is site specific. Generally, large sites with complex hydrogeology will require a greater number than small, hydrogeologically simple sites. Monitor wells should be installed downgradient and upgradient of the waste disposal site in water bearing zones which could transmit contaminants, and in water bearing zones used as a source of water supply (see Figure 3). In the zones which could transmit contaminants, monitoring provisions at strategic points throughout the vertical depth of the aquifer zone should be provided. The final number of well installations is determined by site specific conditions and/or monitoring requirements.

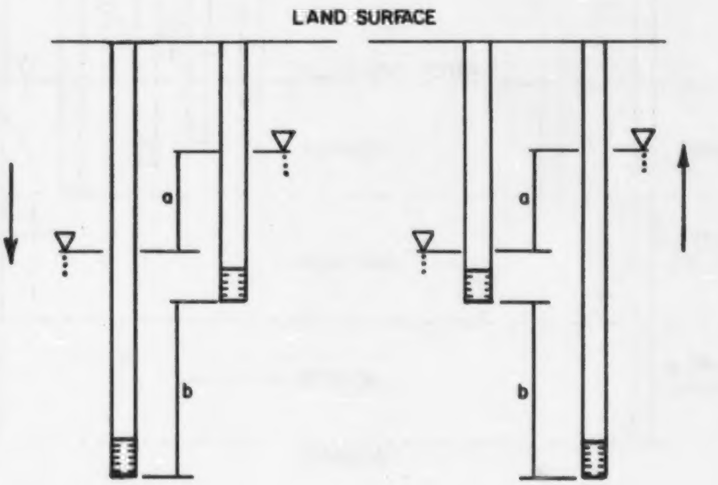
Knowledge of the quality of water encountered as the well is being constructed is highly desirable, and in some instances imperative because such knowledge can affect decisions regarding continued construction, selection of materials, and modifications in construction or in the planned operation of the completed well. Common examples of quality related problems include water zones to be excluded by casing or grouting; choice of casing and screen material; selective casing perforation; and screen placement. The electrical earth resistivity method may provide information on the areal extent of pollution at a reduced cost and within a short period of time. It can be most helpful in planning the test drilling and water sampling program which is still required. By eliminating hit-and-miss drilling, the number of wells needed will be considerably reduced.

## Drilling Boreholes

Efficient well design requires careful selection of the main structural components of a well. These components are the well casing, screen and cap. Component selection is based on the method of well installation, and on the intended use of the well. If possible, dry drilling methods for drilling boreholes for observation and monitoring wells should be used. Various drilling methods are outlined below:

### Air Rotary

Drilling action is accomplished by rotating a drill pipe by means of a power-driven rotary table, with a bit attached to the bottom of the pipe. Compressed air is forced down the drill pipe and through the drill bit. The particles cut by the bit are forced up through the space between the drill pipe and the outside wall of the hole by air pressure and are carried to the surface. Cuttings are collected in accumulators or are blown out away from the operators station.



**KEY**

▤ WELL SCREEN

▽ PIEZOMETRIC ELEVATION IN FEET

→ VERTICAL DIRECTION OF FLOW

i = VERTICAL GRADIENT = a/b

**FIGURE 2**: INSTALLATION OF WELLS TO DETERMINE VERTICAL GROUNDWATER FLOW CHARACTER

(after Mooij and Rovers, 1975)

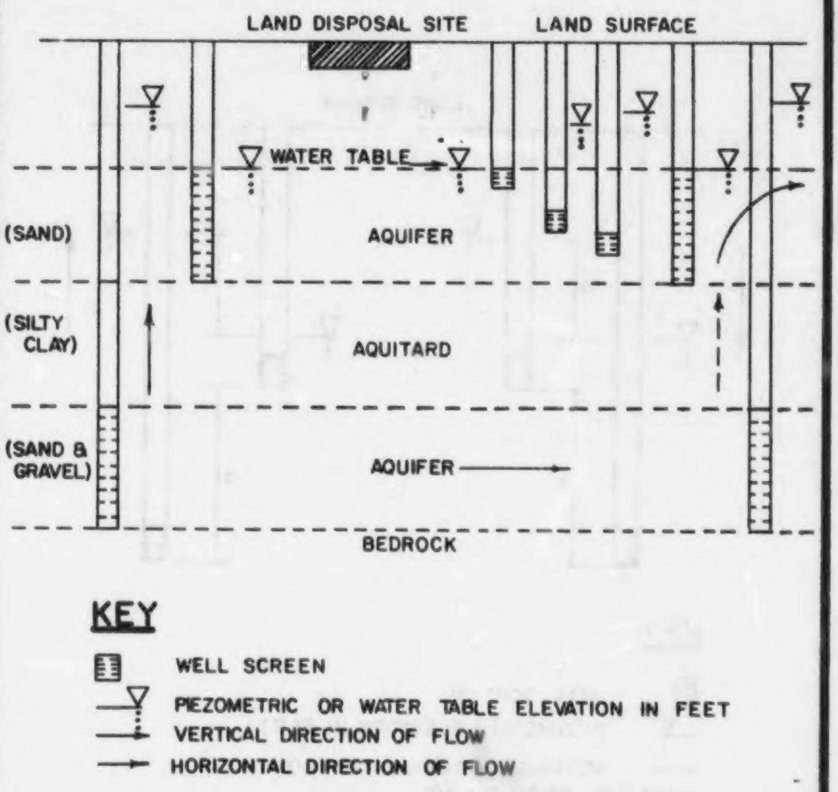

LAND DISPOSAL SITE
LAND SURFACE
WATER TABLE
(SAND)
AQUIFER
(SILTY CLAY)
AQUITARD
(SAND & GRAVEL)
AQUIFER
BEDROCK
KEY
WELL SCREEN
PIEZOMETRIC OR WATER TABLE ELEVATION IN FEET
VERTICAL DIRECTION OF FLOW
HORIZONTAL DIRECTION OF FLOW

**FIGURE 3**: INSTALLATION OF WELLS IN AQUIFERS

(after Mooij and Rovers, 1975)

Advantages: Large quantities of water not necessary on job site. Drillers can observe how much water is being blown out of a well with the cuttings as the hole is deepened.

Disadvantages: Drilling can only be done in consolidated material.

## Auger

Augers are rotated, raised and lowered by power driven mechanisms that deliver the turning force through jointed square or polygonal stems. When the space between the blades of the auger is full of material, the auger is removed from the hole and emptied.

Advantages: Simple operation convenient in situations where water table is close to the surface.

Disadvantages: Not practical for deep well drilling. Difficult to drill below water table when loose sand and gravel are encountered. If a rock or boulder is encountered and cannot be lifted from the hole, then the hole must be abandoned.

## Cable Tool

Wells are drilled by rhythmically lifting and dropping a set of drilling tools suspended on a wire cable so that the tool bit strikes the bottom of the hole. This lifting and dropping develops mechanical energy to break up underground formations and bores the hole. Cuttings are mixed with water and are removed from the hole by a bailer or sand pump.

Advantages: Cable tool sampling and formation logging are simpler and more accurate than with most other rig types. Equipment is suitable for use in rugged terrain. Cable tools require less skilled operators, smaller crews, less accessory equipment, smaller water supplies, and have lower rates of fuel consumption. Cable tool rigs can drill through boulders and fractured, fissured, broken or cavernous rocks.

Disadvantages: Proper drilling motion must be maintained. In unconsolidated formations, pipe or casing must follow the drill bit closely as the well is deepened in order to prevent caving. Depth capacity is limited, but usually adequate for water well construction.

## Driven

Well points are driven into the ground by squarely striking a drive cap with a maul or sledge (manual) or pneumatic tamper, sheet piledriver or cable tool rig. Driven wells are usually started by breaking the surface with an auger.

Advantages: Inexpensive equipment and technique. Easily portable.

Disadvantages: Can be installed only in soft formations which are relatively cobble free. Static water level must be within 15 feet of surface if suction lift is used on well that is less than two inches in diameter.

## Jet

The jet drill is basically a percussion unit and a pressure pump. The pump is mounted on the machine together with pipe and hose connections leading from the pump to the drill pipe, with a return hose connection from the well casing to a pit or other suitable containers. A suction hose returns the water from the pit or container to the pump. The drill pipe which is attached to the cable consists of a small diameter pipe with a bit chisel attached to the bottom section. Water is forced down through the drill pipe by means of the pressure pump and out through the holes in the bit. This water carries the cuttings to the surface through the casing-drill pipe annulus. The lifting and dropping action of the drill pipe chops up the material in the hole and loosens it so it can then be washed to the surface.

Advantages: Very effective in loose unconsolidated formations.

Disadvantages: If hole collapses during construction, casing must be sunk as fast as jetting proceeds. Drilling is generally slow.

## Mud Rotary

Drilling action is accomplished by rotating a drill pipe by means of a power driven rotary table, with a bit attached to the bottom of the pipe. The bit cuts and breaks up the material as it penetrates the formation. Drilling fluid or mud is pumped through the rotating drill pipe and through holes in the bit. Cuttings are carried to ground surface by this fluid as it flows upward in the space outside the drill pipe. Greater fluid flow produces faster drilling. At the surface, drilling mud must flow into a settling pit where cuttings settle out Fluid is then recirculated through the drill pipe by means of a suction pipe.

## Cross Contamination Prevention During Drilling

All drilling and well construction equipment that will be in contact with the borehole should be free of contaminants that may be introduced into the borehole while a well is being constructed. Drilling equipment such as augers; drill rods; and fluid recirculation pumps, hoses and pits should be thoroughly cleaned before drilling commences, after each borehole is drilled, and when all drilling is complete.

Appropriate cleaning techniques include steam cleaning and detergent/water scrubbing, or other approved methods. Chemical cleaners such as hexane or acetone can introduce contaminants and therefore should be analyzed or followed with a detergent wash and clean water rinse.

All mixing/cooling water and wash/rinse water should be tested for parameters to be monitored in the groundwater.

## Observation Well and Monitor Well Construction

While the design of monitor wells should be approved by the permitting agency, the construction must be done by a registered well driller under Public Act 368 of 1978, or a contractor permitted under Act 315 of P.A. 1969. Permits must be obtained before well construction commences. Also, notice to the permitting and/or requesting State agency should be given at least 10 days prior to on-site hydrogeologic study.

### Well Casing

Selection of well casing is dictated by the water quality monitoring requirements for a particular site. Casing and screen must be made of materials inert to suspected contaminants. For example, whenever metal analyses (such as Zn, Pb, Fe) are important, plastic well casing should be used. On the other hand, if organic contaminants are suspected, galvanized steel casing and stainless steel screen should be used. Since rigidity of the well casing may be a concern when using plastic pipe for other than shallow well installations, it is recommended that threaded schedule 80 plastic pipe or larger diameter casing be used. These types of plastic pipe will prevent "kinking" of the casing material.

### Well Diameter

Select well diameter to facilitate the intended purpose of the well. For observation wells the minimum inside diameter of 1¼" may be conducive to water level measurements, but may be too narrow for convenient sampling. Groundwater quality monitor wells often have an inside diameter of two inches. However, if the depth to the static water level is considerable, casing diameter should be increased to facilitate the use of a sampling pump. It should be noted that it is possible to pull the well screen in a 2" well, but it is very difficult to retrieve the screen from an 1¼" well. Also, a 2" well allows easier insertion of instruments and tools, than an 1¼" well allows.

### Well Screening

Well screen, like casing, should be suited to the suspected contaminant being sampled for. Use of multiple screen wells (i.e. wells with screens at various levels and in separate aquifers) is not recommended, so that interaquifer migration of contaminants will be prevented; cluster wells should be used instead. In some cases, an individual aquifer may be multiply screened by a single well. However, the pipe and screen sizes should be of sufficient diameter to accommodate a submersible pump and inflatable packer system. Utilizing the packer system, each screened level can be packed off and pumped separately to collect a representative sample from that level. It should be noted that screening over much of the aquifer thickness can contribute to vertical movement of the contaminants.

Locate screens in the proper portion of the aquifer to be monitored. Screen length should be adequate to supply enough water to obtain a representative sample. However, it should not be of such length that a diluted sample is collected.

### Well Screen Packing

A well-screen sand or gravel pack is recommended for wells located in unconsolidated materials of low permeability (10 slot/60 gauze or smaller). Screen openings should be selected based on the gravel pack grain size. Where a gravel or sand pack is considered to be desirable, the pack should be placed below and above the well screen for a distance of twelve inches or more.

### Grouting

The annular space between the casing and borehole should be grouted with an impervious material such as bentonite, native clay or cement. Grout in such a manner as to 1) protect the aquifer(s) for the purpose of maintaining quality or preserving the hydraulic response of the producing zone(s); and 2) protect the aquifer against entry of unwanted water from the surface or a subsurface zone.

To determine specific grouting requirements of a well at a designated site, consider:

1. Existing surface conditions - especially location of sources of pollution; and

2. Subsurface geologic and hydrogeologic conditions.

When sealing off a formation of undesirable water, grout the annular space from at least 10 feet above to 10 feet below the water producing zone.

## Developing Monitor Wells

Prior to the use of a well for water quality monitoring purposes, well development is needed to ensure the collection of a representative groundwater sample. Well development procedures require periodic flushing of the well, most commonly by bailing or pumping, until groundwater samples are clear, and show consistent results in terms of conductivity, chloride, or hardness.

## Protection of Wells

At all times during the progress of the work the contractor should use reasonable precautions to prevent either tampering with the well or the entrance of foreign material into it. Metal casing should be cleaned before being lowered into a hole. Remove thread cuttings and oil with hexane or other suitable method. In addition, proper sealing of the annular area between the casing and the well bore is particularly important in preventing possible movement of contaminated water down the sides of the casing.

The casing should be securely capped with a locked vented cap. Caps should be vented in such a manner so as to prevent introduction of foreign materials through the vents.

Casing must also be protected against accidental damage. It should be marked adequately to be clearly visible during winter and summer conditions.

Label and identify each well in a permanent manner with owners name, address, phone number, identification number, and tampering warning.

## Reporting Requirements

Initial water level measurements should be made after the screen is set and the static water level has stabilized (allow 24 hours minimum). Elevations, referenced to sea level (U.S.G.S. Datum) or other permanent point, should be surveyed to the nearest hundredth of a foot. The elevation should be taken on top of the well casing. The survey point should be marked on the casing. This should be the same point from which static water level measurements are made to the nearest hundredth (.01) of a foot. Ground elevations should be surveyed to the nearest tenth of a foot. Water level measurements should be taken from screened, cased wells; no data will be accepted from unscreened boreholes.

Locations of the wells should be surveyed and a scaled map drawn with the wells located and survey distances entered. This map should be referenced to a common discernable point (i.e. the section corner, ¼ section corner and/or the intersection of major county or state roads).

Well records for each well should be submitted showing diameter, weight amount, and setting depth of casing; diameter, slot or gauze size; type, length, and setting depth of the well screen; static water level (to the nearest hundredth of a foot) and earth materials penetrated (description of, thickness of, and depth encountered). Samples should be collected as described in the regulations sited below. This information can be entered on:

(a) Standard water well record form as stated in Act 368, P.A. of 1978, if the well was installed by a registered water well driller or drilling contractor; or

(b) Log of soil boring as stated in Act 315, P.A. of 1969, if the well was installed by a soil boring contractor permitted by this act.

### Monitor Well and Test Hole Abandonment

Wells should be properly abandoned according to the Mineral Well Act. Unsealed abandoned wells constitute a hazard to public health, safety, welfare, and to the preservation of the groundwater resource. The sealing of such wells presents a number of problems, the character of which depends upon the construction of the well, the geological formations encountered, and the hydrologic conditions. To seal an abandoned water well properly, several tasks should be accomplished: (1) elimination of physical hazard; (2) prevention of groundwater contamination; (3) conservation of yield and maintenance of hydrostatic head of aquifers; and (4) prevention of the intermingling of desirable and undesirable waters.

The basic concept governing the proper sealing of abandoned wells is the restoration, as far as feasible, of the hydrogeologic conditions that existed before the well was drilled and constructed, for an improperly abandoned well might serve as an uncontrolled invasion point for contaminated and polluted water. Any well that is to be permanently abandoned should be completely filled in such a manner that vertical movement of water within the well bore, including vertical movement of water within the annular space surrounding the well casing, is effectively and permanently prevented, and the water is permanently confined to the specific zone in which it originally occurred.

To seal an abandoned well properly, the character of the groundwater must be considered. If the groundwater occurs under unconfined (watertable) conditions, the chief problem is that of sealing the well with impermeable material so as to prevent the percolation of surface water through the original well opening, or along the outside of the casing, to the water table. If the groundwater occurs under confined or artesian conditions, the sealing operation must confine the water to the aquifer in which it occurs - thereby preventing loss of artesian pressure by circulation of water to the surface, to a formation containing no water, or to one containing water under a lower head than that in the aquifer which is to be sealed.

### Soil Sampling Procedures

This section contains recommended procedures for collecting, handling and analyzing soil samples as part of a hydrogeologic study program.

#### Collecting Soil Samples

Soil samples suitable for field investigation and laboratory characterization should be collected whenever possible during the drilling of boreholes by either coring, split-spoon, or shelby tube sampling at regular intervals. In general, samples collected from auger flights and screened from circulating drilling mud would not provide sufficient accuracy for soil characterization studies.

### Field Handling of Samples

Where necessary, special field handling procedures are to be implemented to insure that the collected soil sample does not alter in character prior to analysis. The recommended procedure for undisturbed soil samples is the sealing of the sample in the shelby tube sampler for transportation to the laboratory. For disturbed soil samples, suitable storage procedures should be followed to minimize soil moisture losses and air contact.

### Extracting and Storing Soil Water

It is recommended that separation of the soil water for analysis be done in the field whenever possible.

### Storing Soil Samples

For prolonged storage of soil samples in the shelby tube it is recommended that plastic or aluminum samplers be used. If hydrocarbon analysis is to be done, however, plastic samplers should not be used.

The storage environment for soil samples in the laboratory should simulate the subsurface environment. Recommended environmental conditions are the absence of light, sealing to prevent contact with air, and a storage temperature from $4^{\circ}C$ to $7^{\circ}C$. Soil samples should not be frozen.

### Analyzing Soil Water

Analysis of soil water pH, Eh, and temperature should be done in the field. Subsequent soil water analysis in the laboratory should include pH, heavy metal content, alkalinity, sodium, sulfate, chloride, calcium, magnesium, total nitrogen and total organic carbon.

## Analyzing Soil Samples

### Field Analysis

In addition to borehole formation sample logging or visual examination of the soil sample characteristics, it is recommended that the analysis of soil pH and temperature be done in the field.

### Undistrubed Soil Laboratory Analysis

The laboratory analysis of undisturbed soil samples should include permeability, cation exchange capacity, organic content, resident exchangeable ions, sieve and hydrometer analysis, clay mineralogy, bulk density, moisture content, and specific gravity.

### Disturbed Soil Laboratory Analysis

It is recommended that the laboratory analysis of disturbed soil samples, except for those collected from direct-circulation-rotary drilling, include: clay mineralogy, cation exchange capacity, sieve and hydrometer analysis, and, specific gravity. In addition, the laboratory analysis of disturbed soil samples collected from dry drilling methods should include organic content, resident exchangeable ions, and moisture content.

### Field Permeability Testing

As an alternative to laboratory testing of soil permeability, field testing by either slug tests or pump tests should be considered. Field testing of in situ soil permeability may result in a more representative value for the coefficient of permeability.

## Water Sampling

### During Drilling

Representative groundwater samples should be collected while monitor and observation wells are being drilled as well as after construction. Samples should cover the entire thickness of the aquifer. Results obtained will act as guides as to the depths at which the wells should be screened. If sampling while drilling is not done carefully, errors in monitor well placement and construction may arise.

## After Well Construction

### Flushing Monitor Wells

To ensure collection of a representative groundwater sample, flushing of the monitoring well before extracting a water sample for analysis is required each time a sample is taken. In the case of wells installed in permeable sediments, a suitable flushing volume should be extracted before sample collection. The most suitable flushing volume is approximately three to five volumes of the water in the casing (See Table I). In the case of a well installed in low permeable soils, the well should be pumped dry and the subsequent incoming water collected for analysis.

Table 1

| Pipe Size in inches | Gallons Per Linear Foot |
|---|---|
| 2 | 0.174 |
| 3 | 0.384 |
| 4 | 0.661 |

Bailing of the wells is an acceptable method for flushing the monitoring wells prior to sample collection. The economics might be improved, however, by installing a permanent water extraction device in the monitoring well.

When evacuation by pumping is employed, the rate of pumping should be based on properties of the aquifer involved. Pumping should not draw water from above or below the portion of the aquifer screened - heavy pumping could dilute the sample.

Collecting Water Samples

Sampling of monitor wells must be done in a way that minimizes or eliminates sample contact with the atmosphere. The method and type of equipment used to collect the water sample is a function of the parameters being sampled for. Components of sampling equipment must be considered when collecting a water sample just as the type of components are considered when constructing the well: e.g. when sampling for organic parameters, plastic (PVC) components of the sampler should be avoided; when sampling for metals, the metal components of the sampler must be non-reactive with the water being sampled. In all cases, construction components of the well and the sampling equipment must be inert to the water being sampled. Also, care must be taken during collection and handling to minimize the contact of the water sample with air. If sampling equipment is intended to be used on more than one well, all parts that contact the water should be conducive to easy and thorough cleaning.

Several methods of extracting water samples from monitor wells are discussed below. As with the construction of the sampling equipment, the nature of the sampling method may affect the quality of a water sample.

Bailers - This method of sample collection involves lowering a container (the bailer) down into the well until it fills with water. Once filled, the bailer is raised to the surface. Bailers are often constructed of either teflon, galvanized steel or polyvinyl chloride (PVC), however, other materials may be used. The type of bailer used is determined by the nature of the chemical parameters suspected to be in the groundwater. If the suspected contaminant is organic in nature, a galvanized steel or teflon bailer should be used rather than a PVC bailer because PVC tends to absorb organics. If metals are the suspected contaminant, a PVC bailer should be used rather than a steel or copper bailer, to ensure that metals are not added to the groundwater sample by the bailer.

Before collecting a groundwater sample, all standing water must be bailed from the well such that three to five complete volumes of water have been evacuated from the well. Depending on the initial volume of water in the well and on the depth to which the bailer must be lowered, bailing standing water may require a great deal of time and effort. If a large volume of water is needed for the sample, the bailer will have to be lowered and raised a number of times.

Use of the bailers may not be acceptable in all instances. Movement of the bailer in the well can cause turbulence of the well water. Agitation of the sample may cause loss of volatile components or precipitation of metals from the sample, thus resulting in a sample that is not representative of the groundwater aquifer.

Pitcher pump - A pitcher pump consists of a hand operated pump which pumps water to the surface by suction. The pump can be threaded directly on the casing of 1¼ and 2 inch wells. For larger diameter wells, a drop pipe is attached to the pump and the drop pipe is placed down the well casing such that the end of the pipe is immersed in the water.

The pitcher pump is convenient to use and can pump relatively large volumes of water. However, it cannot pump water at depths greater than 25 feet. At these depths, suction cannot sufficiently be produced to pump water to the surface. Turbulence which occurs as the sample is collected may have an adverse effect on the water sample. Agitation of the sample can release volatile components and can cause precipitation of metals from the water resulting in a sample that is not representative of the aquifer being sampled. Uncontaminated water must be used for priming.

Air lift pump - In an air-lift pump, air is pumped down the well into the water through an air-lift pipe. As gas bubbles form in the water, the density of the water is reduced and water rises to the surface through the air-lift pipe.

A disadvantage of this method is that gases are introduced into the water sample. Addition of gases both agitates the sample and changes the chemical characteristics of the water. Agitation of the sample can result in the loss of volatile components from the sample. Addition of gases to the sample can alter the pH, carbonate, bicarbonate, and metal levels in the sample.

Shallow well centrifugal pump on suction pump - In this method, a centrifugal pump is used to pump water from a well. A drop pipe (or suction pipe) is connected to the pump. The drop pipe is lowered into the well casing so that the lower end of the pipe is immersed in the well water. When the pump is started, suction is created in the drop pipe and water is drawn up through the pipe to the surface.

This method is easy to use and it is capable of pumping a fairly large volume of water. However, the method can only be used in relatively shallow wells as water cannot be lifted by suction more than 25 feet. Also, the suction may have an adverse effect on the quality of the water sample obtained. The suction may remove dissolved gases from the water sample thus affecting pH and levels of other chemical parameters. Volatile components also may be lost from the sample due to suction.

Centrifugal - jet pump - This method is similar to the suction pump; but instead of just one pipe, two pipes are placed in the well. One of these pipes is fitted with a venturi foot valve. Water is pumped down this pipe. As water passes through the foot valve, it draws additional water from the well and the water is forced up the second pipe. More water is pumped up the second pipe than is pumped down the first pipe due to the intake of water by the venturi unit. Two pipes, however, are not always necessary. One pipe assembly is possible using the well casing as the second pipe.

A jet pump is capable of pumping 40 liters per minute and produces a continuous discharge of water. A disadvantage of the jet pump is that part of the water circulates back down the well and mixes with the sample water. The pump also requires priming so water used for priming must be uncontaminated.

Submersible pump - A submersible pump consists of a stack of impellers, driven by a special motor designed for use underwater. The number of impellers stacked in the pump is determined by the distance the water needs to be lifted to the surface and by the amount of pressure required at the point of delivery. Each time water is pumped from one impeller to the next, its pressure is increased. The motor and pump assembly, which is built as one unit, is let down into the well on the end of a drop pipe to a position below the water table level. In this way, the pumping mechanism is always filled with water and ready to pump.

This type of pump can effectively be used in wells with large volumes of water, wells with great heads, and in deep wells.

Agitation of the sample, caused by the pump, can result in the loss of volatile components from the sample. There are two inch submersible pumps now available that use a non-air-contact lift system that does not cause loss of volatile components due to agitation of the sample.

Tube pump - A peristaltic tube pump operates on a squeeze action principle. Successive waves of contractions force water through the tube to the surface. The water can then be used for sampling purposes.

This type of pump is used in very specialized cases for wells at shallow depths and for sampling purposes only. It cannot pump large volumes of water and therefore cannot be used to purge or develop a well.

## Cross Contamination Prevention

All sampling equipment must be thoroughly cleaned before being introduced into any well.

In the case of highly contaminated sites:

a. Re-usable sampling equipment should be assigned and used only at that particular site.

b. Vehicles, clothing, gloves, etc. taken into a highly contaminated site should be thoroughly cleaned before use at a different site or disposed of.

## Monitoring Parameters

The parameters to be analyzed may vary considerably with each project depending upon the specific purpose or expected contaminants. Some parameters may be of general interest, particularly in preliminary investigatory work, as indicators of possible problems. Specific conductance, which measures the ability of water to carry an electric current due to ionized substances dissolved in the water, can be monitored to indicate the level of inorganic constituents. The pH, a measurement of the hydrogen ion activity expressed as a logarithm, may be of general interest also. Both pH and specific conductance can be accurately performed on site with field portable instruments.

An indication of organic contamination can be found through the analyses of total organic carbon (TOC). Although higher levels of organic carbon may occur naturally in groundwaters, background levels are usually less than 2 mg/l. Higher levels of organic carbon generally indicate organic contamination, but the specific type of contaminants would have to be determined by more sophisticated analyses. Organic carbon analyses require the use of analyzers designed for this determination and would not generally be suited to field analyses. There is a large variety of organic carbon analyzers available from several manufacturers. Certain designs are more practical depending upon the particular applications intended. Some models are much more sensitive than others and may even be able to separately quantify volatile and non-volatile fractions. Sampling requirements may be instrument dependent. Nevertheless, the method employed to measure TOC must be capable of accurately measuring the volatile component or a volatile hydrocarbon scan must be included.

Chemical oxygen demand (COD), although less sensitive than TOC and less specific to organic constituents, may be useful as an indication of gross organic contamination. The main advantage to COD analyses is the use of more common laboratory apparatus. For many samples, the COD is approximately three times higher than the corresponding TOC due to the difference in reporting units.

If inorganic contamination is indicated or suspected, analyses for the common anions and cations should be performed along with probable less common ions. An ion balance analysis of the results (where the cations and anions are converted to milliequivalents, summed separately, and compared) should indicate whether all the major ions present have been measured for possible gross inaccuracies. If all parameters have been analyzed for dissolved constituents, agreement of the cation and anion sums is usually within 5%. The essential anions are usually chloride, sulfate and bicarbonate. Carbonate, nitrate, nitrite, silicate, bromide, fluoride, phosphate, sulfide, and sulfite are necessary on some samples. The necessary cations usually consist of calcium, magnesium, sodium, and potassium.

## Frequency of Sampling

The frequency of sampling by the owner or operator should be designated and approved by the requesting agency. This sampling frequency should be sensitive enough to detect the impacts on or significant changes from the background groundwater quality.

Determine the frequency of sampling by a) rate of groundwater flow, b) potential of affecting existing and future water supplies, and c) chemical composition and characteristics of possible contaminants.

## Reporting of Sampling Results

The owner or operator should develop an approved groundwater sampling and analysis plan. This plan should state the following procedures and techniques:

a) Date and place of sample collection,
b) Sampling method, preservation, and shipment,
c) Analytical procedures including detection limits and units of measurement,
d) Chain of custody control.

The records of analysis required by the owner should be kept throughout the active life of the facility and also throughout the post-closure period.

Submit the results of the analysis to the requesting agency as required after completing the established sampling period.

## Laboratory Methods

Standardized approved analytical laboratory methods must be used to insure the validity and comparability of analytical results. The U.S. Environmental Protection Agency has prepared lists of approved test procedures for the analysis of certain environmental pollutants (e.g. 40 CFR Part 136). The most recent lists are pending review and approval, but can be found in the "Federal Register", Vol. 44, No. 233, December 3, 1979, pp. 69464-69475 and Vol. 44, No. 244, December 18, 1979, pp. 75028-75049. If more than one approved method of analysis is listed, the most applicable method should be employed depending upon the sensitivity required, potential interferences, and other factors.

Occasionally, the use of methods not on the list of approved methods is desired due to expertise with alternate procedures or lack of the necessary equipment, laboratory supplies, or trained personnel to perform the approved method. Alternate test procedure approval should be obtained before an unapproved method is employed. The proposed method of analysis should demonstrate equivalency to an approved method and have precision and accuracy sufficient to perform the desired analyses. Formal application and review by the Michigan Department of Natural Resources may be required.

## Preservation Methods and Holding Time

Many parameters are significantly labile and require special chemical or physical preservation techniques, collection in specific sample containers, and analysis within a certain period of time. "Table II. Containers, Preservation, and Holding Time" (Federal Register, Vol. 44, No. 244, December 18, 1979, pp. 75050-52) lists proposed sample containers, preservation techniques, and maximum holding times for 228 environmental parameters. If the approved procedures cannot be followed and alternate methods of sample preservation or extended holding times are desired, formal application must be made to the Michigan Department of Natural Resources and/or the U.S. Environmental Protection Agency. The proposed method must be compared to the reference method through equivalency testing.

## Quality Control

Careful attention should be paid to the many aspects of sample collection, preservation, handling, and analysis to insure the generation of valid data. Quality control functions are those specific aspects of a project which are designed to insure and monitor the quality of the results. Quality control procedures may not necessarily improve the quality of results, but should define how reliable they are. If problems noted by quality control audits are properly interpreted and corrected, the validity of analytical results will improve. Quality control audits are generally a combination of field and laboratory checks. The Handbook for Analytical Quality Control in Water and Wastewater, March 1979, EPA-600/4-79-019, is a useful reference for establishing quality control procedures and evaluating their results. As a minimum effort, a quality control program may include:

1. Approximately one in twenty-five samples collected in duplicate as a check on sampling techniques and the ability to collect a representative sample;

2. A set of field blanks with each batch of samples to check container suitability and the purity of preservatives;

3. Replicate sample analysis with each analytical batch to check and document the precision of analytical methods;

4. Spiked sample analysis with each analytical batch to audit and evaluate analytical accuracy; and

5. Use of statistically derived control limits to indicate when an out-of-control situation exists and analyses must be repeated.

The following groundwater quality parameters are some of the common parameters which may be required at groundwater monitoring sites:

a. Specific conductance
b. Total organic carbon
c pH
d. Calcium
e. Sodium
f. Magnesium
g. Chloride
h. Sulfate
i. Bicarbonate
j. Chemical oxygen demand
k. Temperature

In addition, site specific parameters are often required. For further definition of necessary monitoring parameters, contact the appropriate State agency regulating the activities to be monitored.

# APPENDIX I

-Part 22. Groundwater Quality Rules, Promulgated Pursuant to Water Resources Commission Act 245, P.A. 1929

-Part 8. Groundwater Sources Rules, Promulgated Pursuant to Safe Drinking Water Act 399, P.A. 1976

-Part 4. Disposal Facility Construction Permits and Standards, Promulgated Pursuant to Hazardous Waste Management Act 64, P.A. 1979

-Part 3. Sanitary Landfills, Promulgated Pursuant to Solid Waste Management Act 641, P.A. 1978

DEPARTMENT OF NATURAL RESOURCES

WATER RESOURCES COMMISSION

GENERAL RULES

Promulgated Pursuant to Act 245, P.A. 1929

Filed with Secretary of State on August 14, 1980. These rules take effect 15 days after filing with the Secretary of State.

(By authority conferred on the water resources commission by sections 2 and 5 of Act No. 245 of the Public Acts of 1929, as amended, being §§ 323.2 and 323.5 of the Michigan Compiled Laws)

The General Rules of the water resources commission are amended by adding R 323.2201 to R 323.2211 to read as follows:

## PART 22. GROUND WATER QUALITY

R 323.2201. Purpose; scope.

Rule 2201. (1) The purpose of the ground water quality rules is to protect the public health and welfare and to maintain the quality of ground waters in all usable aquifers for individual, public, industrial, and agricultural water supplies.

(2) These rules provide for the nondegradation of ground water quality in usable aquifers, define the requirements for hydrogeological study before permitting a discharge into ground waters, establish ground water monitoring requirements for new and existing ground water discharges, and establish a procedure for obtaining variances from these rules.

R 323.2202. Definitions; A to N.

Rule 2202. As used in this part:

(a) "Act" means Act No. 245 of the Public Acts of 1929, as amended, being § 323.1 et seq. of the Michigan Compiled Laws.

(b) "Aquifer" means underground water-bearing earth materials through which ground water moves in sufficient quantity to serve as a source of water supply.

(c) "Aquifer system" means a single aquifer or a series of interconnected aquifers of local or regional extent.

(d) "Change in ground water quality" means a true difference in ground water quality at a site that is considered by the commission to be a true difference, from one point in time to another, after considering the seasonal and locational variation of quality within a site.

(e) "Commission" means the water resources commission.

(f) "Controlled application" means the proper application of a chemical for its intended purpose.

(g) "Degradation" means a change in ground water quality from local background ground water quality, within any portion of a usable aquifer system, which is determined by the commission to be a deterioration in terms of the magnitude of the change and the importance of the parameters describing ground water quality.

(h) "Deterioration" means an impairment of water quality or its value.

(i) "Diffuse source" means any facility or operation which transmits material by seepage or percolation through the soil to the ground waters.

(j) "Discharge" means the addition of materials to ground waters from any facility or operation which acts as a discrete or diffuse source and which requires a permit to discharge pursuant to the act.

(k) "Discrete source" means any facility or operation which transmits materials to the ground waters by a discernible confined conveyance.

(l) "Domestic waste" means wastes generated and discharged as a result of normal household activities.

(m) "Existing ground water quality" means concentrations of the physical, biological, chemical, and radiological parameters representative of the ground water quality in usable aquifers at a site at the time of permit issuance, permit renewal, or nonpermitted discharge as determined by the hydrogeological study required by rule 2207.

(n) "Ground water" means underground water within the zone of saturation.

(o) "Hazardous material" means those substances that, singly or in combination, pose an unacceptable, existing, or potential risk to human health or to the environment because they may be flammable, explosive, reactive, corrosive, toxic, radioactive, infectious, carcinogenic, bioconcentrative, persistent, or irritating when present in sufficient concentrations.

(p) "Hydrogeological determination" means the collection, interpretation, and presentation of hydrologic and geologic data to provide an adequate understanding of existing conditions and to determine the potential impact on the ground waters of a discharge from an operation or activity.

(q) "Industrial waste" means waste from industrial or manufacturing processes, or from a trade or business, as distinct from domestic or sanitary waste.

(r) "Local background ground water quality" means concentrations of the physical, biological, chemical, and radiological parameters representative of the ground water quality in usable aquifers at a site having virtually no influence by discharges as determined by the hydrogeological study required by rule 2207.

(s) "Monitoring well" means a well that is specifically designed to measure the impact of a discharge on the ground waters.

(t) "Non-contact cooling water" means water used for cooling which does not come into direct contact with any raw material, intermediate product, by-product, waste product, or finished product.

R 323.2203. Definitions; O to W.

Rule 2203. As used in this part:

(a) "Observation well" means a well that is specifically designed to determine existing hydrogeological conditions.

(b) "Parameters" means those specific characteristics describing the physical, chemical, biological, and radiological conditions of the ground water quality.

(c) "Person" means an individual, partnership, association, corporation, industry, municipality, state agency, or interstate body.

(d) "Radioactive materials" means natural or synthetic materials which give off particles or rays, or both, from nuclear reactions whereby the particles or rays pose an unacceptable, existing, or potential risk to human health or to the environment.

(e) "Sanitary waste" means treated or untreated wastes that contain human metabolic wastes and domestic wastes.

(f) "Sludge" means concentrated residues generated or produced by industrial activities or by the treatment of industrial or sanitary wastes.

(g) "Solid waste" means refuse, garbage, rubbish, ashes, or other materials in solid form.

(h) "Toxic material" means a substance that is or may become harmful to plant life, animal life, or to food chains when the substance is present in sufficient concentrations or combinations.

(i) "Usable aquifer" means an aquifer, or that portion of an aquifer or aquifer system, that is capable of providing water in sufficient quantity and of satisfactory quality, as determined from the hydrogeological study required by rule 2207, to serve 1 or more protected uses. Usable aquifers do not include aquifers used for mineral, oil, or gas production, as regulated by Act No. 315 of the Public Acts of 1969, as amended, being §319.211 et seq. of the Michigan Compiled Laws, and known as the mineral well act, and Act No. 61 of the Public Acts of 1939, as amended, being §319.1 et seq. of the Michigan Compiled Laws, the act which regulates oil and gas in Michigan.

(j) "Well" means a properly designed and constructed hydraulic structure that permits measurement or withdrawal of ground water from an aquifer.

R 323.2204. Protected uses.

Rule 2204. All ground waters of the state, in usable aquifers and of a quality suitable for use as individual, public, industrial, or agricultural water supply, shall be protected for these uses.

R 323.2205. Nondegradation of ground waters in usable aquifers; permissible and prohibited discharges.

Rule 2205. (1) The quality of ground waters in all usable aquifers shall not be degraded from local background ground water quality as the result of a discharge, except as provided in rule 2210.

(2) Discharges into ground waters may be made, consistent with the requirements of the act and applicable rules, if necessary measures are taken to prevent the degradation of ground waters in usable aquifers. The following are such measures:

(a) Proper waste water treatment.
(b) Proper facility site selection.
(c) Controlling the zone of saturation at the site.
(d) Providing percolation and seepage barriers.
(e) Use of underdrainage.
(f) Containment of the discharge within the boundaries of the operation or activity defined by the hydrogeological study required by rule 2207.

(3) Materials at concentrations that exceed the maximum contaminant levels for inorganic and organic chemicals specified in the national interim primary drinking water regulations, 40 C.F.R. §§141.11 and 141.12, which are promulgated pursuant to the safe drinking water act 42 U.S.C. §300f, shall not be discharged into ground waters in usable aquifers even in those cases where the local background ground water levels for these materials exceed the specified levels.

R 323.2206. Regulation of discharges.

Rule 2206. A person shall not discharge into the ground waters any substance that is, or may become, injurious to the public health, safety, or welfare, or to the domestic, commercial, industrial, agricultural, recreational, or other uses which are being or may be made of the ground waters. Discharges into ground waters of the state are regulated by permits issued in accordance with sections 7(1) and 8(b) of the act.

R 323.2207. Determination of existing hydrogeological conditions; report.

Rule 2207. (1) A determination of existing hydrogeological conditions or study, including existing ground water quality, shall be made in the vicinity of proposed or existing discharges.

(2) The person responsible for the discharge shall provide the hydrogeological study.

(3) At each discharge site, at least 1 hydrogeological study, or its equivalent, shall be required to develop the discharge permit.

(4) For existing permitted discharges, a hydrogeological study, or its equivalent, shall be required at the time of permit renewal when an approved or presently acceptable hydrogeological study is not available. The continued permitting of an existing discharge shall be contingent on satisfactory hydrogeological conditions at the site, as determined by the hydrogeological study. The commission shall provide sufficient time for the hydrogeological study to be developed by the person responsible for the discharge.

(5) The following are the purposes of a hydrogeological study:

(a) To establish the impact that a discharge may have on ground water contained in usable aquifers.

(b) To determine, through interpretation of available and collected data, the acceptability of discharging at the site.

(c) To determine existing ground water quality.

(d) To determine local background ground water quality.

(e) To define engineering modifications that may make the discharge acceptable.

(f) To define a proposed ground water monitoring program.

(g) To define the usable aquifers.

(h) To define the areal and vertical extent of the site earth materials that assimilate and transmit the discharge.

(6) The acceptance of a site shall be determined on the basis of the hydrogeological study and consideration of proper engineering modifications.

(7) One of the following criteria shall be considered in determining whether an aquifer is usable:

(a) Whether an aquifer is presently serving a protected use.

(b) Whether an aquifer, as defined by the hydrogeological study, can potentially serve the protected uses.

(c) Whether a well can be constructed in the aquifer meeting the requirements of part 127 of Act No. 368 of the Public Acts of 1978, as amended, being §333.12701 et seq. of the Michigan Compiled Laws, an act relating to water well drilling, and Act No. 399 of the Public Acts of 1976, as amended, being §323.1001 et seq. of the Michigan Compiled Laws and known as the safe drinking water act.

(8) Hydrogeological studies shall be prepared by or under the direction of a qualified ground water or engineering geologist or a registered professional engineer with assistance from experts in related fields, such as land surveying, environmental science, and soil science.

(9) Determination of hydrogeological conditions shall cover sufficient area to allow for a definition of the impact of the discharge on ground water in a usable aquifer. The determination shall take into account the local geology and the surface and ground water conditions, including water quality parameters specific to each site. The following minimum elements shall be required in determining the impact of the discharge on ground water in usable aquifers:

(a) The concentrations of the following water quality parameters shall be determined at each site:

(i) Specific conductance as an indication of the dissolved solids.

(ii) Determination of the concentration of the following parameters for chemical balance and indicators for comparison of water quality:

| Cations | Anions |
|---|---|
| Calcium | Chloride |
| Sodium | Sulfate |
| Magnesium | Bicarbonate |

(b) Additional ground water quality parameters may be required. These additional parameters shall be selected by the commission on a case-by-case basis if the parameters can be justified on the basis of any 1 of the following criteria:

(i) The parameters may cause degradation in usable aquifers and are present or likely to be present in the discharge.

(ii) The parameters can demonstrate that a discharge to a usable aquifer is occurring.

(iii) The parameters can be used to define the existing or local background ground water quality.

(c) The following categories include examples of some of the parameters that may be required in addition to the minimum parameters specified in subrule 9(a) of this rule:

(i) Industrial wastewater: chemical oxygen demand, metals, organic compounds, hazardous, and toxic materials.

(ii) Industrial sludge: chemical oxygen demand, metals, organic compounds, hazardous, and toxic materials.

(iii) Municipal wastewater: nitrite nitrogen, nitrate nitrogen, ammonia nitrogen, total phosphorus, metals, methylene blue active substances.

(iv) Municipal sludge: nitrite nitrogen, nitrate nitrogen, ammonia nitrogen, total phosphorus, metals, methylene blue active substances.

(v) Sanitary landfills: total iron, chemical oxygen demand, nitrite nitrogen, nitrate nitrogen, ammonia nitrogen, metals, hazardous, and toxic materials.

(d) A map of the site and surrounding area drawn to scale showing the distance to existing wells and the properties in the surrounding area having potential for groundwater supplies; existing lakes or ponds; streams, springs, and swamps; direction of surface drainage and the direction of ground water movement in the site area; locations of borings, observation wells, and other well data used in the determination, shall be provided. Wells used in making ground water quality determinations shall be identified.

(e) Sufficient water well records. Observation wells or borings shall be required to determine the composition of subsurface earth materials in order to locate usable aquifers and to establish the degree of connection with the discharge.

(f) Sufficient data or not less than 3 observation wells shall be required to determine the ground water flow direction and possible variations plus the depth to the ground water and possible variations in depth. The top of the well casings shall be referenced to a common or United States geological survey datum.

(g) Evaluation of site earth materials shall be made to determine the ability of these earth materials to assimilate, by physical, chemical, or biological means, the various constituents of the discharge.

(h) Evaluation of the ability of the site earth materials to percolate and transmit the volume of liquids resulting from the discharge shall be made.

(i) The nature, extent, and consequence of mounding resulting from the discharge that can be anticipated to occur above the highest naturally occurring water table may be required.

(j) A description of the proposed engineering modifications that will ensure control of the discharge shall be provided for those discharges that may degrade water quality in usable aquifers.

(k) A determination of the horizontal and vertical flow system to properly determine the location and depth to be monitored, especially when mounding is superimposed on the existing system, may be required.

(l) A ground water monitoring program shall be proposed, including the design, location, and depth of monitoring wells and the methods of sampling.

(m) Compilation and interpretation of data, maps, and charts based on site conditions to support conclusions and recommendations shall be included with the study.

(10) The Commission shall decide the acceptability of the hydrogeological study or its equivalent. The commission may exclude the requirements of this rule on a case-by-case basis, if the criteria, limitations, or conditions necessary to protect the usable aquifer are met.

R 323.2208. Ground water monitoring.

Rule 2208. (1) Ground water monitoring shall be required for all discharges to assist in the determination of compliance under rule 2211. Ground water monitoring shall include collection of water quality and water level data from a well or group of wells that are specifically designed to adequately assess the impact of any discharge on ground water. The design of the ground water monitoring system shall be based on the hydrogeological study; consideraiton of the local geology, surface water, and ground water conditions specific to each site; and the type of discharge. These factors shall determine the number of locations, number of wells at each location, and depth of each well.

(2) Monitoring wells shall be located and completed at depths as specified in the hydrogeological study so as to intercept any discharge from the site to ground water contained in a usable aquifer.

(3) Monitoring well design and construction elements shall include the following criteria:

(a) The drilling method shall be specified.

(b) Monitoring wells completed in fine-textured earth materials shall have special construction, such as gravel packing around the screen.

(c) Monitoring wells shall have suitable equipment and methods for sampling ground water, as specified in the hydrogeological study.

(d) Construction of monitoring wells shall be by a water well driller registered under Act No. 294 of the Public Acts of 1965, as amended, or a contractor regulated by Act No. 315 of the Public Acts of 1969, as amended. Monitoring well construction shall be as specified in the approved hydrogeological study.

(e) Casings shall be installed so as to prevent vertical leakage of fluids between the casing and the drill hole, and shall be capped and provided with a cap locking device. Use of a vented cap is desirable but care shall be taken to prevent introduction of contaminants through such vents.

(f) The well casing shall be protected against accidental damage and shall be adequately marked so as to be clearly visible during winter and summer conditions.

(g) Each well shall be labeled and identified by the owner's name, owner's address, the well number, the use of well, and a warning.

(h) When a monitoring well is to be permanently abandoned, approved plugging procedures shall be followed as provided in Act No. 294 of the Public Acts of 1965, as amended, or by Act No. 315 of the Public Acts of 1969, as amended.

(4) The person responsible for a discharge shall provide for the design, installation, and operation of the ground water monitoring system.

(5) The commission shall decide the acceptability of the ground water monitoring system. The commission may exclude the requirements of this rule on a case-by-case basis, if the criteria, limitations, or conditions necessary to protect the usable aquifer are met.

R 323.2209. Activities not requiring a hydrogeological report, ground water monitoring, and discharge permits.

Rule 2209. (1) The following activities do not require a permit from the commission or a hydrogeological report or ground water monitoring, except as may be required by the commission on a case-by-case basis, where such activities are or may become injurious to the protected uses of a usable aquifer:

(a) Disposal of sanitary wastes in volumes of less than 10,000 gallons per day through the use of septic tank and ground disposal systems approved by local county and district health departments that are certified by the commission.

(b) Controlled application of dust-suppressant chemicals used with normally accepted or regulated practices.

(c) Controlled application of de-icing chemicals used with normally accepted or regulated practices.

(d) Controlled chemical applications for natural resource and right-of-way programs used with normally accepted or regulated practices.

(e) Controlled application of chemicals for domestic purposes used with normally accepted or regulated practices.

(f) Controlled application of chemicals for agricultural and silvicultural use by normally accepted or regulated practices.

(g) Disposal of non-contact cooling water, not treated by the addition of chemicals, in volumes established at the discretion of the commission.

(h) Retention of storm water runoff in surface impoundments or surface waterways.

(2) Other activities may be excluded as determined by the commission on a case-by-case basis, if the criteria, limitations, or conditions that the commission deems necessary are met.

R 323.2210. Variances.

Rule 2210. (1) Variances from the requirements of rule 2205 may be granted by the commission.

(2) Variances may be granted by the commission for exceptional circumstances where it is determined by the commission that strict conformity with rule 2205 is not economically or technically feasible, that a prudent alternative does not exist, and that such variance is consistent with the promotion of the public health, safety, and welfare in light of the state's paramount concern for the protection of its natural resources.

(a) A variance shall not be granted under this rule for discharges containing hazardous materials in amounts or concentrations which singly or in combination pose an unacceptable, existing, or potential risk to human health or the environment.

(b) In granting variances under this rule, the commission shall prescribe such criteria, limitations, or conditions as the commission deems necessary to protect the public health of present or future ground water users affected by the variances. Such conditions shall include preventing the degradation of ground water in other usable aquifers, prescribing treatment techniques, or providing an alternate approved water supply.

(c) All variances granted by the commission under this rule shall require a discharger or proposed discharger to the waters of the state to affirmatively demonstrate the need for a variance in terms of the criteria specified in this subrule.

(d) Before granting a variance under this rule, the commission shall provide for adequate public notice and opportunity for public hearing.

(3) Variances granted under this rule to dischargers required to be permitted by the commission pursuant to the requirements of the act shall be reviewed by the commission at the time of permit reissuance.

R 323.2211. Determination of compliance.

Rule 2211. (1) The Commission shall determine compliance with these rules on the basis of all reports and information available.

(2) In making tests or analyses of water or waste to determine compliance with the rules, samples shall be collected in such a manner that the location, number, and frequency are considered satisfactory by the commission. The samples shall be preserved and analyzed pursuant to procedures outlined in 40 C.F.R. §136.1 et seq., promulgated pursuant to section 304(g) of the federal water pollution control act, as amended, 33 U.S.C. §1314, or analyzed pursuant to 40 C.F.R. §141.1 et seq., promulgated pursuant to section 1401(1) of the safe drinking water act, 42 U.S.C. §300f which are herein adopted by reference, or pursuant to other methods prescribed or approved by the commission. Copies of 40 C.F.R. §136.1 et seq. and 40 C.F.R. §141.1 et seq. are available at a cost of $2.25 from the Department of Natural Resources, P.O. Box 30028, Lansing, Michigan 48909, and from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Promulgated Pursuant to Act 399, P.A. 1976

## PART 8. GROUND WATER SOURCES

R 325.10801. Purpose.

Rule 801. The purpose of this part is to establish certain requirements and objectives for the isolation and construction of wells which shall be met by public water supplies to provide a continuous, adequate quantity of water meeting the state drinking water standards.

R 325.10802. Applicability; approval of deviation from minimum standards and requirements.

Rule 802. (1) The provisions of this part apply to wells used to supply ground water for a public water supply. These rules are minimum standards and requirements which shall be considered by the department in the issuance of permits or approvals for waterworks systems.

(2) Deviations from the minimum standards and requirements prescribed by this part may be approved by the department upon a showing by an owner of a public water supply that a deviation will not adversely affect the public health. Deviations from this part shall be by permit condition for type I or type II public water supplies, and in writing by the department for type III public water supplies.

R 325.10804. Type III public water supplies; applicability of other rules.

Rule 804. Suppliers of water of type III public water supplies shall comply with the applicable provisions of rules of the department promulgated pursuant to Act No. 294 of the Public Acts of 1965, as amended, being §§ 325.221 to 325.240 of the Michigan Compiled Laws, and entitled, "Part 1. Well Construction Code," being R 325.1601 to R 325.1676 of the Michigan Administrative Code, except where specific requirements for type III public water supplies prescribed by this part are more restrictive.

R 325.10805. Retroactivity of rules; significant changes or major repairs made to existing well; utilization of well not in compliance with this part.

Rule 805. (1) This part is not retroactive for individual well installations constructed before the effective date of these rules except:

(a) When water quality from the well does not meet the state drinking water standards.

(b) Upon a determination by the department that continued use of a well represents a health hazard, or

(c) When a well is found to be in violation of previous rules of the department which were in effect at the time of construction.

(2) Significant changes or major repairs made to an existing well after the effective date of these rules shall conform to the provisions of this part. Those changes shall include, but are not necessarily limited to, replacing the casing, modifying the depth of a well, installing new pumping equipment of a different type or of higher capacity, or modifying the pump setting. In general, a significant change or major repair shall be considered to have occurred if the pumping capacity is increased above the original capacity as a result of the work. A significant change or major repair shall not include routine maintenance or incidental repairs.

(3) A supplier of water proposing to utilize water from a well or well field not in compliance with this part may be required to provide continuous treatment of the water in a manner acceptable to the department and shall obtain written approval from the department before utilizing that well or well field as part of a public water supply.

(4) a ground water source may be granted special consideration by the department for the location and construction of wells used as a raw water source prior to treatment.

R 325.10806. Change in classification of public water supply.

Rule 806. Requirements or criteria prescribed by this part for the various types of public water supplies shall be based on the facilities which the public water supply is intended to serve. If the volume of water used or the type of facilities or number of units served by a public water supply changes in such a way as to cause a change in the classification of a public water supply, the supplier of water shall meet requirements applicable to the new classification.

R 325.10807. Location of well.

Rule 807. (1) A well shall be located with due consideration given to the extent of the property, the contour of the land, elevation of the site, the depth to the water table, other geological characteristics. local ground water conditions, and other factors necessary to provide a safe and reliable public water supply. A well shall meet all of the following requirements:

(a) Located so the well and its surrounding area is controlled and protected from potential sources of contamination.
(b) Adequate in size, design, and development for the intended use.
(c) Constructed to maintain existing natural protection against contamination of water bearing formations and to prevent all known sources of contamination from entering the well.
(d) Protected against the entry of surface water.

R 325.10808. Standard isolation area, generally.

Rule 808. The standard isolation areas from any existing or potential sources of contamination including, but not limited to, storm and sanitary sewers, pipelines, septic tanks, drain fields, dry wells, cesspools, seepage pits, leeching beds, barnyards, or any surface water, other area or facility from which contamination of the ground water may occur, are established for public water supplies as follows:

(a) For type I and type IIa public water supplies, the standard isolation area is an area measured with a radius of 200 feet in all directions from the well.

(b) For type IIb and type III public water supplies, the standard isolation area is an area measured with a radius of 75 feet in all directions from the well.

R 325.10809. Standard isolation area; modification; approval.

Rule 809. (1) Modifications of the standard isolation area, if any, shall be determined for a site based on a study of hydrogeological conditions provided to the department by a supplier of water pursuant to R 325.10813 and R 325.10814.

(2) The department may require an increase or approve a decrease in the standard isolation area of a well.

(3) Approval of the isolation area shall be obtained from the department before construction of a production well used for drinking or household purposes as part of a public water supply.

R 325.10811. Sewers within approved isolation area.

Rule 811. (1) A storm or sanitary sewer shall not be located within the approved isolation area of a well for a type I or type IIa public water supply.

(2) A buried sewer, located within the approved isolation area for a type IIb or type III public water supply, shall be constructed with materials and joints as approved in writing by the department.

R 325.10812. Location of wells with respect to major sources of contamination.

Rule 812. Wells serving type I and type IIa public water supplies shall be located a minimum distance of 2,000 feet, and wells serving type IIb and type III public water supplies shall be located a minimum distance of 800 feet, from known major sources of contamination including, but not limited to, large scale waste disposal sites, land application of sanitary wastewater or sludges, sanitary landfills, and chemical or waste chemical storage or disposal facilities. Based on hydrogeological studies, the department may require an increase or approve a decrease in the 2,000 foot distance for type I or type IIa public water supplies or the 800 foot distance for type IIb or type III public water supplies.

R 325.10813. Study of hydrogeological conditions by supplier of water of type I and type IIa public water supplies.

Rule 813. (1) A supplier of water of a type I or type IIa public water supply shall prepare a study of hydrogeological conditions for determination of an isolation area and the acceptability of a proposed location of a well. The study shall be provided to the department and approval obtained.

(2) Previous studies of hydrogeological conditions shall be considered by the department in determining the scope of or need for a study required by this rule.

(3) A study of hydrogeological conditions shall mean investigations and a compilation and evaluation of data necessary to determine the isolation area, acceptability of a well location and construction, and the availability of water at that location. The study of hydrogeological conditions may include the following:

(a) The type of public water supply.
(b) The proposed well capacity.
(c) The proposed well depth and well construction features.
(d) Identification of geological formations including the thickness and characteristics of the aquifer, the number and thicknesses of protective layers, and if deemed necessary by the department, the areal extent of the protective formations.
(e) Location of the well relative to sources of contamination.
(f) Susceptibility of the area to flooding.
(g) Depth to the water table from the established ground surface.
(h) Proximity of the well to surface water.
(i) A yield test of the well in accordance with R 325.10830.
(j) Water quality analyses.

(4) The scope of the hydrogeological study may vary depending upon the capacity of the proposed well in relation to the aquifer capacity, the need for a modification of a standard isolation area, or other factors; and may include additional determinations required by the department, such as the general aquifer characteristics and interference relative to other wells in proximity to the well site.

R 325.10814. Studies of suppliers of water of type IIb and type III

Rule 814. If a modification of the standard isolation area is requested by a supplier of water of a type IIb or type III public water supply, the supplier shall submit to the department and obtain approval for a study of hydrogeological conditions consistent with the capacity of the well and the capacity of the aquifer.

R 325.10815. Procedures for department approval of a proposed well for type I and type II public water supplies.

Rule 815. (1) In reviewing the location and acceptability of a proposed well for a type I or type II public water supply, the department shall determine whether the following procedures have been followed by a supplier of water:

(a) Approval has been obtained from the department for each proposed land parcel on which a test well is to be located.
(b) For type I public water supplies, ownership or adequate control as required by R 325.10810 or an option for

ownership or adequate control of the required isolation area has been secured.

(c) Where required, a study of hydrogeological conditions has been approved by the department.

(d) Satisfactory yield tests have been completed on the test well or the well capacity has been established to the satisfaction of the department.

(e) Water quality analyses show results meeting the state drinking water standards.

(2) When the department finds that a proposed well, its location and its construction features meet the requirements of this part, the department shall authorize construction of a production well or conversion of a test well to a production well.

R 325.10816. Location of well in area subject to flooding.

Rule 816. (1) A well shall not be located in an area subject to flooding unless the well is protected as approved in writing by the department. The ground surface immediately adjacent to a well casing shall be graded so that surface water is diverted away from the casing. Surface flooding shall not be allowed closer than 25 feet from the well.

(2) The top of a well casing, any other opening into the well casing, well appurtenances, and controls shall be not less than 2 feet above the greater of the following:

(a) One hundred year flood elevation.

(b) The maximum recorded flood elevation.

R 325.10817. Top of well casing; elevation.

Rule 817. The top of a well casing shall terminate not less than 12 inches above the established ground surface, or the floor of a pump room, well room, or well house. In addition, for type IIb and type III public water supplies the top of a well casing may terminate not less than 12 inches above the floor of an approved basement offset.

R 325.10818. Minimum well casing depth.

Rule 818. Casings for all wells serving public water supplies shall extend not less than 25 feet below the established ground surface.

R 325.10819. Well casing in rock formation.

Rule 819. (1) In an area where a well is to be developed in fractured, jointed, or cavernous rock, the well shall not be approved as a production well unless all of the following conditions exist:

(a) Adequate protective material above the aquifer.

(b) No evidence of aquifer contamination.

(c) No direct flow from surface or near surface sources to the rock aquifer.

(2) The department may also approve a well developed in fractured, jointed, or cavernous rock based on special well construction features and a hydrogeologic study.

R 325.10820. Water suction lines.

Rule 820. (1) A casing shall not be used as a suction line unless protected by a permanent outer casing.

(2) For type I and type IIa public water supplies, a buried water suction line extending outside the well casing is prohibited.

(3) For type IIb and type III public water supplies, a buried water suction line extending outside the well may be used if protected in a manner approved by the department.

(4) Any buried pump discharge line shall be under positive pressure at all times.

R 325.10821. Casing materials.

Rule 821. All casings used for wells serving a public water supply shall be of materials approved in writing by the department.

R 325.10822. Grouting.

Rule 822. (1) Grouting may be required by a method approved by the department to obtain a tight bond between the well casing and the undisturbed natural earth formations, thus preventing the entrance of any surface water or near surface contaminants to the ground water source.

(2) Grouting may be required to protect the well casing from corrosion, where necessary.

(3) Grouting may be required by the department where a reduction in the standard isolation area of a well is proposed.

R 325.10823. Flowing artesian wells; well construction.

Rule 823. In areas where flowing artesian wells are commonly encountered, the well construction methods proposed by a supplier of water to protect a flowing artesian aquifer and confining strata shall be submitted to the department by the supplier of water and approval obtained prior to the start of construction.

R 325.10824. Flowing artesian wells; flow control.

Rule 824. For flowing artesian wells, a direct connection between a discharge pipe for flow control and a sewer or other source of contamination is prohibited.

R 325.10825. Elevation of discharge from well casing; location of connection to well casing.

Rule 825. (1) For type I and type IIa public water supplies, a discharge from a well casing at an elevation less than 12 inches above the established ground surface is prohibited, except where an installation with an approved pitless adapter is permitted by the department.

(2) For type IIb and type III public water supplies, a connection to a well casing may be at least 12 inches above the floor of an approved basement offset, pump room, or well room, or the requirements of subrule (1) shall be met.

R 325.10826. Construction and location of room housing pumping equipment or room housing top of well casing.

Rule 826. (1) For type I and type IIa public water supplies, a room housing pumping equipment or a room housing the top of a well casing, where used, shall be constructed above the established ground surface allowing access to the pump for maintenance or repair.

(2) For type IIb and type III public water supplies, a room housing pumping equipment may be located below the established ground surface if it is located in or attached to an approved basement or is drained to the ground surface by gravity.

R 325.10827. Tail pipe or pump suction pipe; termination.

Rule 827. In screened wells, the bottom of a tail pipe or pump suction pipe shall terminate not less than 5 feet above the top of the screen.

R 325.10828. Casing vents; sampling tap; relief valves.

Rule 828. (1) Casing vents shall be:

(a) Provided on all wells and constructed to prevent the entrance of contaminants into the well.

(b) Extended to the outside atmosphere above the roof level if toxic or flammable gases are present.

(2) Provisions shall be made for collection of water samples by installation of a proper sampling tap in a convenient location as close to each well as possible.

(3) Air-vacuum relief valves, where used, shall be constructed to prevent entrance of contaminants into the well.

R 325.10830. Yield or performance testing requirements.

Rule 830. (1) Each well constructed to serve a public water supply shall be tested for yield or performance, by a method approved by the department, after installation of a production well and prior to use of a well to supply water to a waterworks system.

(2) For type I and type IIa public water supplies, yield tests or performance tests shall be performed on the test well or production well. The tests may be required to:

(a) Determine the adequacy of well depth and development.

(b) Secure water samples for quality analyses.

(c) Determine well capacity and production on a long term basis.
(d) Determine drawdown.
(e) Select permanent pumping equipment.
(f) Evaluate well efficiency.
(g) Assure proper utilization and protection of ground water aquifers.

(3) For type IIb and type III public water supplies, yield tests or performance tests of wells shall demonstrate that water can be safely withdrawn from an aquifer in sufficient quantity to provide water for drinking and household purposes and of a quality meeting the state drinking water standards.

R 325.10831. New or reconditioned well; disinfection; water samples.

Rule 831. (1) A new or reconditioned well or pump installation or well facility which is opened for maintenance or inspection shall be pumped to waste until the water is as clear as reasonably possible. Thereafter the well and pumping equipment shall be properly disinfected.

(2) Prior to placing a new or reconditioned well or a well facility which is opened for maintenance or inspection into service, not less than 2 consecutive water samples for bacteriological analyses shall be collected from the installation and each analysis shall show results meeting state drinking water standards. Analyses for other contaminants may be required by the department.

R 325.10832. Abandoned wells.

Rule 832. An abandoned well shall be properly filled and sealed to prevent it from becoming a hazard or serving as a channel for contamination of the ground water or the escape of subterranean gas.

R 325.10833. Sanitary protection of ground eater sources.

Rule 833. Water from ground water sources with limited or no sanitary protection including springs, shall not be used as a water source for a public water supply, unless followed by complete treatment prior to distribution.

Promulgated Pursuant to Act 64, P.A. 1976

## PART 4. DISPOSAL FACILITY CONSTRUCTION PERMITS AND STANDARDS

R 299.6401 Construction permits generally.

Rule 401. (1) Issuance of a construction permit by the director shall occur before any of the following occurs:

(a) The construction of a new disposal facility.

(b) The expansion or enlargement beyond the previously authorized capacity or area of a disposal facility.

(c) The alteration of the method of disposal previously authorized at a disposal facility to a different method of disposal. A change in only the types or quantity of waste disposed, without an expansion, enlargement, or alteration of the facility, shall not require a construction permit. Such a change may require modification of the operating license as set forth in part 5 of these rules.

(2) A separate construction permit is required for each method of disposal employed at a disposal facility.

(3) A person who proposes to expand, enlarge, or alter a disposal facility or construct a new disposal facility shall submit to the department, on forms provided by the department, a construction permit application setting forth the information required by R 299.6402.

(4) The department shall accept only complete construction permit applications. Further processing of an incomplete construction permit application may be suspended until the applicant has supplied the necessary information or otherwise corrected the deficiency. The statutory timetable of section 19(2) of the act shall begin upon receipt of a complete construction permit application.

(5) The department shall notify the applicant within 30 days after receipt of a construction permit application. Such notification shall include the date of receipt and whether any required items were missing.

(6) The department shall notify the applicant of the construction permit status within 75 days after the complete construction permit application is received.

(7) A construction permit shall not be transferable from the original owner/operator to a new owner/operator without the approval of the director by a modification to the construction permit.

(8) A totally enclosed treatment facility which is located on the site of a generator and which does not treat hazardous waste from other generators shall not be considered a disposal facility.

R 299.6402 Construction permit application; content.

Rule 402. (1) An application for a construction permit shall include all of the following items:

(a) Construction permit application fee or deposit as calculated in R 299.6403.

(b) General information as follows:

(i) Disposal facility name, location, and mailing addresses.

(ii) Owner's and operator's names and mailing addresses, including name and address of the titleholder of the land on which the disposal facility is to be constructed.

(iii) Contact person for the site.

(iv) Type and purpose of the disposal facility.

(v) Site description.

(vi) List of existing and pending environmental permits for the disposal facility.

(vii) Engineering plan prepared by a registered professional engineer and sealed as required by act 240.

(viii) Estimated construction time.

(ix) Estimated useful life of the disposal facility.

(x) Site master plan, plot plan, and site layout.

(xi) Date operation began or will begin.

(xii) Number of days of operation per year.

(xiii) Number of hours of operation per day.

(xiv) Type of process to be used at the disposal facility.

(xv) The design capacity of each process.

(xvi) Amount of each type of waste to be disposed of at the disposal facility.

(xvii) Identification of the process which will handle each waste type.

(xviii) Flow diagram of the entire disposal operation.

(c) Supplemental technical information as follows:

(i) Hydrogeological report consistent with rules promulgated by the department for groundwater quality standards.

(ii) Environmental assessment detailing the disposal facility's impact on the air, water, other natural resources, and human health during all ranges of normal operation.

(iii) The failure mode assessment.

(iv) Proposed disposal operations plan with supporting data, calculations, and scientific and technical references relied upon, if any, including all of the following, as applicable:

(A) A description of the chemical characteristics and physical properties of the classes of wastes to be disposed of at the disposal facility.

(B) A description of the procedure to be employed to verify that the waste received meets the chemical characteristics and physical properties described in subparagraph (A) of this paragraph.

(C) A detailed waste management plan, including plans for handling, storing, and disposing of the wastes.

(D) The types of hazardous wastes generated at the disposal facility, if any, and the proposed method of disposal for each such waste.

(E) A description of any discharge or emission from the disposal facility for which a state or federal permit is required.

(F) A description of any pollution control equipment to be installed at the disposal facility.

(v) Spill and accident prevention plan which meets the requirements of R 299.6407.

(vi) Contingency plan and emergency procedures which meet the requirements of R 299.6408.

(vii) Site security plans which meet the requirements of R 299.6406.

(viii) Recordkeeping procedures which will be carried out to provide information required in R 299.6901 and R 299.6902.

(ix) Environmental monitoring program which meets the requirements of R 299.6409.

(x) Closure plans, including cost estimates, which meet the requirements of R 299.6410.

(xi) Post-closure maintenance and monitoring plan, including cost estimates, which meets the requirements of R 299.6411.

(xii) Proposed method of demonstrating financial capability which meets the requirements of R 299.6504.

(xiii) If a trial burn is proposed under R 299.6422(b), the proposed trial burn procedures and time period of the trial burn.

(xiv) Any other information needed to demonstrate compliance with the requirements of this part.

(2) The department may require more or less information than that specified in subrule (1) of this rule. Whether more or less information is necessary will depend on what is necessary to determine either of the following:

(a) Conformance with the requirements of this part.

(b) That the proposed disposal facility will not cause pollution, impairment, or destruction of the natural resources of the state.

(3) The construction permit application shall be signed by the owner and the operator of the disposal facility, including the titleholder of the land on which the disposal facility is to be constructed, as follows:

(a) For a corporation, by a principal executive officer of at least the level of vice president.

(b) For a partnership or sole proprietorship, by a general partner or the proprietor.

(c) For a governmental agency, by either a principal executive officer or ranking elected official.

R 299.6403 Construction permit application fee schedule.

Rule 403. (1) The applicant shall calculate the construction permit application fee by totalling the appropriate fees in items (1), (2), (3), and (4) of table 403.

(2) The calculated fee shall be attached to the construction permit application.

(3) The applicant may request that the application fee be based on actual work hours required for construction permit review. This request shall be made in writing on the construction permit application. The applicant shall be assessed the actual review cost fee. The difference between the actual review cost fee and the calculated fee submitted with the application shall be refunded or billed within 60 days after the construction permit is approved or denied.

(4) An applicant who has requested that the application fee be based on actual review costs forfeits the further opportunity to use calculated fees according to table 403.

(5) Each incinerator, landfill, treatment facility, long-term storage facility, or other method of disposal requires a separate construction permit and separate application fee.

(6) If a construction permit application is not resubmitted after being found to be administratively incomplete, the entire application fee shall be refunded.

(7) If a construction permit application is denied, no portion of the application fee shall be refunded.

(8) Any reapplication of a revised proposal within 6 months of denial shall be assessed only the actual costs to review the revised proposal. These actual costs shall not exceed the calculated fee from table 403.

(9) Applicants withdrawing construction permit applications within 14 days of department receipt shall have 70% of the original application

fee refunded or shall be charged actual review costs if the option under subrule (3) of this rule was chosen.

(10) Applicants withdrawing construction permit applications within 30 days of department receipt shall have 35% of the original application fee refunded or shall be charged actual review costs if the option under subrule (3) of this rule was chosen.

(11) Applicants withdrawing applications after 30 days after department receipt may be issued a refund, at the discretion of the department, which is not greater than 35% of the original application fee or may be charged actual review costs if the option under subrule (3) of this rule was chosen.

(12) Table 403 reads as follows:

Table 403
Permit fee schedule

| Item | | | Landfills and inground disposal and storage | Other treatment and long-term storage |
|---|---|---|---|---|
| (1) Site size | (a) | Less than 5 acres | $100.00 | $ 50.00 |
| | (b) | 5 to 19 acres | 170.00 | 100.00 |
| | (c) | 20 to 79 acres | 240.00 | 100.00 |
| | (d) | 80 acres or more | 320.00 | 100.00 |
| (2) Projected waste volume per day | (a) | Less than 50 cubic yards or 10,000 gallons | 60.00 | 50.00 |
| | (b) | 50 to 100 cubic yards or 10,000 to 20,000 gallons | 80.00 | 100.00 |
| | (c) | 101 to 700 cubic yards or 20,000 to 140,000 gallons | 100.00 | 100.00 |
| | (d) | More than 700 cubic yards or more than 140,000 gallons | 130.00 | 150.00 |
| (3) Hydrogeological characteristics | (a) | Natural clay | 40.00 | - |
| | (b) | Natural sand | 60.00 | - |
| | (c) | Compacted clay | 70.00 | - |
| | (d) | Artifically lined (other materials) | 100.00 | - |
| | (e) | Any combination of above | 100.00 | |
| | (f) | Surface water on site | - | 75.00 |
| (4) Type of facility | | Landfill | 9000.00 | |
| | | Incinerator | 7200.00 | |
| | | Other method of disposal involving:<br>(a) Actual or potential air emissions<br>(b) Surface water discharge<br>(c) Placement of materials into the land or potential groundwater discharge | 7200.00 if none or 1 of (a), (b), or (c) applies<br>8100.00 if 2 of (a), (b), or (c) apply<br>9000.00 if (a), (b), and (c) all apply | |

R 299.6404 Environmental and human health standards generally.

Rule 404. All disposal facilities shall be located, designed, constructed, and operated in a manner that will prevent all of the following:

(a) Groundwater or surface water contamination which causes a violation of the federal clean water act or act 245.

(b) Air emissions in violation of the federal clean air act or act 348.

(c) Contamination of a sole source aquifer.

(d) Exposure of humans or the environment to harmful quantities of hazardous waste or hazardous components of wastes.

(e) Pollution, impairment, or destruction of the natural resources of the state.

(f) Violations of the federal resource conservation and recovery act and regulations promulgated in 40 C.F.R. §§260 to 265, which are available as set forth in R 299.7303.

R 299.6405 Disposal facility standards generally.

Rule 405. (1) All disposal facilities with discharges to surface water or groundwater, including discharges from leachate collection systems or surface water runoff collection systems, shall comply with the federal clean water act and act 245. Additionally, disposal facilities with discharges, other than sanitary sewage, to municipal sewerage systems shall meet applicable pretreatment standards and shall have the written approval, on a form provided by the department, of the municipal treatment system accepting that discharge.

(2) All disposal facilities shall be designed, constructed, and operated so that fugitive emissions of hazardous wastes or hazardous waste components are controlled.

(3) All disposal facilities shall have diversion structures constructed, operated, and maintained to be capable of diverting all surface water runoff away from the active portions of the disposal facility for a 24-hour, 100-year storm.

(4) Surface water runoff, up to the quantity anticipated from a 24-hour, 100-year storm, from active portions of a disposal facility shall be collected and confined before discharge or treatment as required under the act, the federal clean water act, and act 245.

(5) Fail-safe concepts shall be employed in all aspects of disposal facility design.

(6) Before storing, disposing of, or otherwise managing, a hazardous waste, the owner/operator of the disposal facility shall verify the typical or specific properties in sufficient detail to allow compliance with the requirements of the construction permit and operating license.

(7) Unless exempted under subrule (8) or (9) of this rule, disposal facilities shall not be located in any of the following areas:

(a) In an active fault zone.

(b) In a floodway designated by the department under act 245.

(c) In a coastal high-risk area designated under the shorelands act.

(d) In a floodplain.

(e) On a wetland.

(f) Over a sole source aquifer or the recharge zone of a sole source aquifer.

(g) Within 60 meters of adjacent property lines, for active portions of a facility. Greater isolation distances may be required by the department based on the review of information in the construction permit application and location of private water wells. The Michigan department of public health shall be consulted when private water wells may be affected.

(8) The department may grant an exemption from the provisions of subrule (7)(e) to (g) of this rule if the applicant demonstrates that the provisions of R 299.6404 are met and all other necessary permits are issued.

(9) The department may grant an exemption from the provisions of subrules (3), (4), and (7)(d) of this rule for disposal facilities other than landfills and land treatment.

R 299.6406 Site security.

Rule 406. (1) Entry to the disposal facility shall be controlled. Entry through each access point to the active portion of the disposal facility shall be controlled by a responsible individual or a device when the disposal facility is in operation. Each access point shall be secured to prevent inadvertant entry and to minimize the possibility of unauthorized entry when the disposal facility is not in operation.

(2) At a minimum, a fence or other barrier capable of preventing inadvertant entry and minimizing the possibility of unauthorized entry of persons and domestic livestock shall be constructed around the active and closed portions of the disposal facility. Closed portions of the disposal facility include areas where hazardous wastes have been disposed of and which have been shut down or covered or are otherwise inactive.

(3) A warning sign shall be prominently displayed at each access to the disposal facility. The sign shall, as a minimum, have the following legend: "WARNING - Unauthorized Personnel Keep Out". The sign shall consist of block letters not less than 10 centimeters in height on a high contrast background. Additional signs around active portions of the disposal facility providing more specific warnings or indicating the nature of the disposal facility may be required by the department.

R 299.6407 Spill and accident prevention plan.

Rule 407. (1) Disposal facilities shall be designed, operated, and constructed so that the likelihood of an accidental release of hazardous wastes or hazardous waste components is minimized.

(2) The owner/operator shall develop, and update as necessary, a plan to prevent spills, accidental releases of hazardous wastes or hazardous waste components, and other accidents.

(3) The spill and accident prevention plan shall include, at a minimum, all of the following:

(a) Surveillance procedures and schedules.
(b) Routine maintenance procedures and schedules.
(c) Equipment and disposal facility inspection procedures and schedules.
(d) Employee training.
(e) Emergency secondary containment provisions.
(f) Alarm systems.

(4) The current copy of the spill and accident prevention plan shall be filed with the department. Any changes from a previously approved plan require approval of the department and incorporation into the operating license.

(5) All employees at the disposal facility shall be trained in the provisions of the spill and accident prevention plan.

R 299.6408 Contingency plan and emergency procedures.

Rule 408. (1) The owner/operator shall develop a contingency plan setting forth action to be taken in case of the accidental release of hazardous waste or hazardous waste components.

(2) The contingency plan shall, at a minimum, contain all of the following:

(a) Appropriate emergency contacts and notification procedures.

(b) A list and description of emergency equipment and power sources available.

(c) An outline of emergency procedures for spill containment and cleanup.

(d) An employee training program.

(e) The names of responsible individuals and their phone numbers.

(f) Evacuation plans.

(g) Potential disposal methods for spilled or released hazardous wastes, hazardous waste components, and contaminated cleanup materials.

(h) Internal and external communications systems.

(3) The contingency plan shall be reviewed annually by the owner/operator and shall be revised as necessary. The current contingency plan shall be available for review by the department. The department may require changes in the current contingency plan based on such a review.

(4) The current copy of the contingency plan shall be readily accessible onsite to employees at the disposal facility. All employees at the disposal facility shall be trained in the provisions of the contingency plan.

R 299.6409 Monitoring systems.

Rule 409. (1) Monitoring systems shall be installed to detect both of the following:

(a) Failure of the facility design or operational capabilities.

(b) Release of hazardous wastes or hazardous waste components.

(2) At a minimum, the owner/operator shall do all of the following:

(a) Install, maintain, and operate a groundwater monitoring system as determined to be necessary based on the hydrogeological report on the site and to demonstrate compliance with R 299.6404. Installation of all wells shall be pursuant to the provisions of part 127 of act 368 and act 315. In addition, all monitoring wells shall be cased and the space between the borehole and the well casing shall be filled with an impermeable material adequate to seal the borehole and to prevent the entry of surface water and groundwater.

(b) Collect and analyze a sample from each groundwater monitoring well at a frequency stipulated in the construction permit and operating license.

(c) For each groundwater monitoring well sample, provide the department, within 60 days from sample collection, the chemical analyses for site specific parameters determined by the department based on types of wastes present and disposed of at the disposal facility.

(d) Conduct an annual soil monitoring program in the immediate vicinity of the disposal facility to detect contamination by hazardous wastes or hazardous waste components originating from the disposal facility.

(e) Conduct an ambient air monitoring program to detect contamination by hazardous wastes or hazardous waste components originating from the disposal facility.

(3) Immediately upon detection of hazardous wastes or hazardous waste components by monitoring programs, the owner/operator shall do all of the following:

(a) Notify the department.

(b) Determine the source of the hazardous waste or hazardous waste components.

(c) Determine the extent of the contamination.

(d) Immediately take appropriate action to contain the source and remove the contamination.

(4) The department may waive portions of subrule (2) of this rule if the owner/operator demonstrates that such monitoring is not required or that a lesser degree of monitoring can be utilized to demonstrate compliance with the act and these rules.

(5) The department may require more intensive or extensive monitoring programs if needed to demonstrate compliance with the act or these rules.

R 299.6410 Closure plans and costs.

Rule 410. (1) The owner/operator shall provide a plan for closure of the disposal facility which meets the requirements of part 6 of these rules.

(2) At a minimum, the closure plan shall include all of the following:

(a) A description of closure procedures and plans.

(b) The anticipated operating life of the disposal facility and the estimated time to close the disposal facility. If any partial closures are anticipated, they shall be described in a similar manner.

(c) A description of proposed procedures for decontaminating equipment.

(d) Disposal locations for materials contaminated during closure.

(e) A description of possible uses of the land after closure is completed.

(f) Estimated costs for closure and justifications for these estimates.

(3) The closure plan shall be updated as necessary. At a minimum, the closure plan shall be updated when an application for an operating license is made and when an existing operating license is modified.

R 299.6411 Post-closure maintenance and monitoring plans and costs.

Rule 411. (1) The owner/operator shall provide a plan for maintenance and monitoring of the disposal facility for 15 years after closure or for a shorter period if approved by the director.

(2) At a minimum, the post-closure plan shall include all of the following:

(a) Provisions for limiting access to the disposal facility, if necessary.

(b) Provisions for monitoring, as set forth in R 299.6409, until permission to stop monitoring is received in writing from the department.

(c) Provisions for periodic inspection and maintenance of the site, remaining facilities, and equipment.

(d) Estimated costs of post-closure maintenance and monitoring.

(3) The post-closure plan shall be updated as necessary. Such an update shall be approved by the department and incorporated into the operating license. At a minimum, the post-closure plan shall be updated when an application for an operating license is made and when an existing operating license is modified.

R 299.6412 Permit time period.

Rule 412. (1) A construction permit is valid for 3 years from date of issuance.

(2) Extensions of the construction permit may be granted by the director if unexpected construction delays occur.

R299.6413 Permit denial.

Rule 413. (1) The director shall deny an application for a construction permit if the proposed disposal facility would violate the act or these rules.

(2) The applicant is on notice that the department shall deny the construction permit in either of the following situations:

(a) The applicant has not submitted the appropriate permit fee or

(b) The applicant has not submitted sufficiently detailed or accurate information or information of the correct type to enable the department to make reasonable judgments as to whether the disposal facility could comply with the act and these rules.

(3) The director shall notify the applicant in writing of reasons for denial.

R 299.6414 Permit revocation.

Rule 414. The director may revoke a construction permit under the provisions of section 47(c) of the act.

R 299.6415 Landfill standards.

Rule 415. (1) A landfill shall be located, designed, constructed, and operated so that there is no direct contact between the landfill and surface waters or groundwater. The vertical distance between the bottom of the landfill liner and the water table shall be large enough so that water table fluctuations will not result in contact of the water table with the hazardous waste, the landfill liner, or any constructed portion of the landfill. A safety factor shall be applied to account for uncertainty in the water table fluctuations. If artificial means must be used to lower the water table to meet this requirement, the dewatering system shall operate by gravity only.

(2) The hydrogeological characteristics of the site shall be determined to indicate soil conditions, aquifers, and subsurface characteristics. This information shall be consistent with the groundwater quality requirements of act 245 for assessing the impact of the proposed landfill. Pump tests and permeability tests to determine subsurface conditions may be required by the department.

(3) A landfill shall not be located in an area where there is less than 6 meters of soil with a permeability of $1 \times 10^{-6}$ cm/sec or less, immediately below and lateral to the liner. The department may allow substitution of a back-up liner of equivalent design if it can be demonstrated to provide equivalent environmental protection.

(4) At a minimum, the landfill isolation requirements for public water supplies shall meet the requirement of act 399. The department may require an increase in isolation requirements for the facility based on review of hydrogeologic data, engineering evaluations, wastes to be disposed of, or other data.

### R 299.6416 Landfill liner standards.

Rule 416. A liner shall be provided which meets, at a minimum, all of the following requirements:

(a) Before final cover, during the time period that the landfill is open, the liner shall provide for containment of wastes and accumulated water. The liner shall also provide for the containment of any leachate which may be generated after final cover is applied. All of the following shall be considered in determining liner requirements:

(i) Type of wastes.
(ii) Waste characteristics.
(iii) Typical or specific waste properties.
(iv) Quantity of wastes.
(v) Expected precipitation.
(vi) Characteristics of the clay liner material.

A safety factor shall be applied to account for variations or uncertainty in the factors which affect the ability of the liner to provide liquid containment.

(b) Notwithstanding the performance requirements of subdivision (a) of this rule, at a minimum, the liner shall be constructed of compacted clay which is a minimum of 150 centimeters thick and which has a permeability coefficient of $1 \times 10^{-7}$ cm/sec or less and shall meet all of the following minimum criteria:

(i) Meet criteria for a unified soil classification of CL or CH as determined by ASTM standard D2487-69 (reapproved 1975), which is adopted by reference in R 299.7301.

(ii) More than 25% of the soil particles shall be less than 5 microns in size.

(iii) Be placed in horizontal lifts uniformly and thoroughly compacted to the standards approved in the design. However, the material shall not be compacted to less than 90% of the maximum dry density as determined by the modified proctor test described in ASTM standard D1557-70, which is adopted by reference in R 299.7301.

(iv) Permeability and leachate component attenuation characteristics shall not be adversely affected by the waste or its components, as determined by available scientific information.

(c) Based on characteristics of the site and waste, the department may require a liner of greater thickness.

(d) A synthetic liner may be substituted for a portion of the compacted clay liner if equivalent containment and resistance to degradation are demonstrated. The engineering certification required in section 22(3) of the act shall include the integrity of the liner after field installation. A synthetic liner shall meet all of the following minimum criteria:

(i) Be of adequate strength and thickness to insure mechanical integrity.
(ii) Not be adversely affected by the waste or its components.
(iii) Be resistant to attack from soil bacteria, fungus, and burrowing animals.

(iv) Be able to withstand the stress of extreme heat, freezing, and thawing.

(v) Have adequate tensile strength to elongate sufficiently and withstand the stress of installation and use of machinery and equipment.

(vi) Be of uniform thickness and be free from thin spots, cracks, tears, blisters, and foreign particles.

(vii) Be placed on a stable base.

(e) The liner system shall have a slope of not less than 1% at all points and shall be connected at all low points to 1 or more leachate collection sumps which meet the specifications of R 299.6418 so that leachate formed in the landfill will flow by gravity into the leachate collection sumps from which the leachate can be removed and treated or disposed of as specified in R 299.6418.

(f) Alternative liner designs and installations providing equivalent environmental and human health protection may be approved by the department. The applicant shall prove equivalency.

R 299.6417 Landfill cover standards.

Rule 417. (1) Cover of 15 centimeters of soil of equivalent permeability to the natural underlying material required by R 299.6415(3) shall be installed over the waste at the end of each workday.

(2) The final cap shall be essentially impermeable to precipitation. Notwithstanding this performance requirement, all of the following minimum final cover requirements shall be met to minimize leachate generation after closure:

(a) The final cap shall consist of a minimum of 150 centimeters of compacted clay meeting the requirements of R 299.6416(b).

(b) The cap shall have a permeability not adversely affected by gases generated by the waste or its components, as determined by available scientific information.

(c) The cap shall be graded and sloped to preclude surface water infiltration into the hazardous waste and to preclude ponding of surface water. The department shall inspect the cap when completed.

(d) The top of the cap shall be covered with topsoil to serve as a final cover capable of supporting shallow-rooted vegetation. This final cover is in addition to the 150-centimeter thick compacted clay cap.

(e) Vegetation shall be established at the earliest possible time and shall be maintained to stabilize the cap and prevent erosion. The vegetation shall be shallow-rooted and shall not penetrate into the cap.

(f) The owner/operator shall inspect and maintain the final cover to ensure integrity of the cap after closure. Any indications of failure, such as visible cracks or increased leachate generation, shall be identified, reported to the department, and repaired immediately.

(g) A venting system shall be established to prevent accumulations of gas. If required under act 348, gas emissions shall be monitored, collected, and treated. The venting system shall be installed in a manner which does not adversely effect the impermeable cover. The department may exempt the applicant from this provision if the applicant demonstrates that gas will not be generated in the landfill.

(3) Landfill cover methods providing equivalent impermeability to precipitation may be approved by the department. The applicant shall prove equivalency.

R 299.6418 Landfill leachate collection, removal, and treatment.

Rule 418. (1) A leachate collection and removal system shall be provided for all hazardous waste landfills. This system shall meet all of the following minimum requirements:

(a) The liner shall be sloped as required in R 299.6416(e). A leachate collection system shall be installed overlaying the liner which is not less than 30 centimeters in thickness and which is composed of permeable material which is capable of permitting leachate to move rapidly through the system and into the leachate collection sump and which will not have its permeability reduced by the leachate.

(b) A leachate collection sump shall be designed and constructed of materials both compatible with, and impermeable to, the leachate formed in the landfill. A leachate removal system shall be designed to remove liquids from the sump. The sump shall be accessible for removal of leachate and as necessary for maintenance of the leachate removal system. The sump shall have a volume equal to or greater than 1 month's expected volume of leachate, but not less than 4,000 liters.

(c) Daily cover and waste placement in cells shall be done in such a manner that the flow of leachate in the collection system to the sump is not impeded.

(2) During and after closure, leachate shall continue to be withdrawn until no leachate collects in the sump. The sump shall then be checked at least annually to determine if leachate is being generated.

(3) Any leachate collected during landfilling operations or during and after closure shall be considered a hazardous waste.

(4) Leachate collection and removal systems providing equivalent ability to eliminate liquid head on the landfill liner may be approved by the department. The applicant shall prove equivalency.

R 299.6419 Landfill failure correction system.

Rule 419. (1) Engineered into the landfill shall be an early failure detection, containment, and removal system, such that failure of the systems specified in R 299.6415 to R 299.6418 which results in leachate escape shall be detected and the leachate contained and removed.

(2) A contingency plan shall be prepared for removing leachate which is detected and contained by the system specified in subrule (1) of this rule before it reaches the uppermost aquifer below the landfill or moves horizontally off the site of the landfill.

(3) Immediately upon detection of the leachate containing hazardous wastes or hazardous waste components outside the landfill liner, the owner/operator shall notify the department and shall, by excavation, boring, or other investigative techniques, determine what failures have occurred in the systems designed to prevent leachate generation and escape. These failures shall be repaired immediately, and the escaped leachate shall be removed as specified in the contingency plan. The leachate shall be collected and treated or disposed of in accordance with the provisions of the act and these rules.

(4) The department may grant an exemption from subrules (1) and (2) of this rule if the applicant can demonstrate that equivalent protection of the environment and human health is provided without an early failure detection system.

R 299.6420 Waste disposal in landfill.

Rule 420. (1) Incompatible wastes shall not be disposed of in a landfill in a manner that could ever permit the contact of one incompatible waste with another.

(2) The contents and location with respect to permanently surveyed benchmarks of each daily waste deposit shall be recorded in the operating log required under R 299.6901.

(3) None of the following hazardous wastes shall be disposed of in a landfill:

(a) Ignitable waste as described in R 299.6201(c).

(b) Reactive waste as described in R 299.6201(e).

(c) Bulk or containerized liquids, semisolids and sludges, unless such waste is treated or stabilized to reduce its liquid content or to increase its solids content so that a non-flowing consistency is achieved to eliminate the presence of free liquids before final disposal in a landfill.

(4) The department may approve, in writing, an exception to subrule (3)(c) of this rule if other disposal methods are not practical. The exception can only be approved if the waste is containerized and surrounded by specifically placed sorbent material capable of absorbing all the liquid contents of the container without generating any free liquid under landfill conditions.

(5) Empty containers shall be crushed or otherwise reduced in volume before disposal in a landfill.

R 299.6421 Incinerator performance standards.

Rule 421. (1) The mass emission rate of the toxic components from an incinerator shall not exceed any limitations established pursuant to act 348.

(2) An incinerator shall not emit to the atmosphere more than 0.1% of the mass of each combustible toxic component or more than 1% of the mass of each noncombustible toxic component contained in the waste being incinerated, unless a limitation has been established for that component pursuant to subrule (1) of this rule.

(3) The incinerator shall operate in conformance with all applicable limits and conditions of the federal and state laws listed in section 25 of the act.

R 299.6422 Waste incineration approvals.

Rule 422. The owner/operator shall demonstrate to the department the ability of the facility to incinerate the combustible toxic components of wastes in compliance with R 299.6421(2) using 1 of the following methods:

(a) The owner/operator may demonstrate that the incinerator is designed and operated in conformance with the design criteria of table 422. To encourage innovative technology, incinerators may be designed and operated at other conditions of temperature, retention time, and combustion efficiency if the owner/operator can demonstrate that an equivalent degree of destruction efficiency will occur. Table 422 reads as follows:

Table 422
Incinerator design criteria

| Waste type | Minimum conditions<br>Combustion zone temperature (degrees Celsius) | Retention time (seconds) | Oxygen in exiting combustion gases (%) |
|---|---|---|---|
| Halogenated aromatic hydrocarbons | 1200 | 2 | 3 |
| All other combustible toxic components | 1000 | 2 | 2 |

(b) The owner/operator may propose a trial burn. The proposed trial burn procedures and time period shall be submitted in the construction permit application. If approved by the department, the procedures shall be incorporated in the construction permit. The trial burn shall include, at a minimum, all of the following determinations:

(i) An analysis of the hazardous waste for concentrations of organohalides and for toxic components specified by the department.

(ii) An analysis of the ash residues and scrubber effluent for toxic components.

(iii) An analysis of the exhaust gas for concentrations of toxic components, hydrogen halides, CO, $CO_2$, $O_2$, and total particulates.

(iv) A measurement of combustion zone temperature and computation of residence time.

(v) A computation of destruction efficiency for each toxic component specified by the department.

(vi) A computation of scrubber efficiency in removing halogens, if applicable.

(vii) Those additional items listed in R 299.6423.

(c) The department may require a trial burn as described in subdivision (b) of this rule when the owner/operator chooses the method described in subdivision (a) of this rule if needed to demonstrate compliance with the act or these rules.

R 299.6423 Incinerator monitoring.

Rule 423. The owner/operator of an incinerator shall monitor and record all of the following in each trial burn required by the department and each operational burn:

(a) Combustion zone temperature.

(b) Oxygen content in the exhaust gas at the exist of the combustion zone.

(c) At regular intervals of not longer than 15 minutes, the rate of hazardous waste, fuel, and air fed to the combustion system. The department may approve modifications of this requirement if the applicant demonstrates equivalent environmental protection.

(d) Any other parameter necessary for proper operation of the automatic hazardous waste feed shutoff system required by R 299.6424(1).

R 299.6424 Incinerator requirements.

Rule 424. (1) The incinerator shall be operated with a functioning device to automatically shut off the hazardous waste feed to the incinerator in event of any of the following:

(a) The failure of any parameter critical to thermal destruction of hazardous waste such that R 299.6421 may be violated.

(b) The failure or partial loss of operating capability of any device for control of halogen emissions to the atmosphere.

(c) The failure of monitoring operations critical to thermal destruction of the hazardous waste.

(2) Except as provided in R299.6421(1), an incinerator used to thermally degrade hazardous waste containing more than 0.5% by weight of organically combined halogens shall provide a means of removing 99.0% by weight of the mass of resultant halogens from the exhaust gases.

R 299.6425 Treatment standards.

Rule 425. (1) The owner/operator shall demonstrate to the department in the construction permit application that the method and process proposed for the treatment of each hazardous waste will render the waste nonhazardous, safer for handling or transport, amenable to recovery, amenable to storage, or reduced in volume.

(2) The materials used in construction of the treatment facility shall be compatible under expected operating conditions with the hazardous waste and any treatment chemicals or reagents used in the treatment process.

(3) The owner/operator shall determine and specify in the construction permit application all of the following:

(a) The proper treatment technique, the proper feed rates of treatment chemicals or reagents, and the proper operating conditions, such as temperature, pressure, and flow rate.

(b) Whether the waste or treatment chemicals or reagents will have any detrimental effect on the materials used for construction, such as causing corrosion, dissolution, saltings, or sealings. If detrimental effects are possible, the method of controlling them shall be specified.

(c) Whether the waste contains any components or contaminants which may interfere with the intended treatment process or decrease the effectiveness of the treatment and, if so, how the interferences will be controlled.

(d) Whether the waste contains components or contaminants which may cause the release of toxic gases or fumes during the intended treatment and, if so, how they will be controlled.

(e) Whether the waste contains components or contaminants which may form highly toxic components with the treatment chemicals or reagents during the intended treatment and, if so, how they will be controlled.

(4) Trial tests, including bench scale, pilot plant scale, or other appropriate tests, shall be performed for each hazardous waste which is new or significantly different from hazardous waste previously treated to determine treatment technique and operating conditions and to evaluate the effectiveness of the treatment process and consequences of the proposed treatment.

(5) All treatment chemicals or reagents used in a treatment process shall be stored in such a manner as to minimize the potential for spills, fires, explosions, or uncontrolled discharges or releases.

(6) All uncovered reaction vessels shall be sized to provide not less than 60 centimeters freeboard to prevent splashing or spillage of hazardous waste during the treatment process.

(7) A treatment facility shall have the capacity to receive emergency transfer of all reactor contents and shall have emergency storage capacity to be used in the event of an equipment breakdown or malfunction.

(8) A facility which continuously feeds hazardous waste into the treatment process shall be equipped with an automatic waste feed cutoff or a by-pass system which is activated when a malfunction in the treatment process occurs which may result in environmental contamination.

(9) All treated wastes, residuals, or by-products from a treatment process shall be evaluated under R 299.6203 to determine whether they are hazardous wastes.

R 299.6426 Long-term storage.

Rule 426. The owner/operator shall do both of the following:

(a) Demonstrate that the long-term storage facility will contain the hazardous waste.

(b) Comply with all provisions of the part 7 short-term storage rules.

R 299.6427 Deep well injection.

Rule 427. (1) Hazardous wastes may be disposed of via class I injection well systems, if all aspects of act 315 are complied with and if the department has determined that the injection well system will provide long-term underground containment which is adequate to comply with the act and these rules.

(2) To make the determination of adequacy required in subrule (1) of this rule, the applicant shall submit all of the following information for review by the department:

(a) The volume of wastes to be injected and the rates of injection.

(b) The typical properties of the wastes, including their acute and chronic toxicity.

(c) The types of failures which could occur in the injection well system and remedial measures to be taken in case of failures.

(d) The population and area of the state potentially affected by the failures described in subdivision (c) of this subrule.

(e) All of the following geological and hydrological information:

(i) The uniformity of the receiving geological formation.

(ii) The areal extent of the receiving geological formation.

(iii) Whether the proposed receiving geological formation is sufficient to accept the waste at the proposed maximum rate of injection.

(iv) Whether the porosity and permeability of the receiving geological formation are sufficient to allow injection at the proposed pressures.

(v) Whether the receiving geological formation is of sufficiently low pressure to avoid fracturing during operation of the system.

(vi) Whether the receiving geological formation contains an aquifer or connects to any aquifer.

(vii) Whether adequate overlying and underlying geologic structures are present which are fracture-resistant and which will not allow passage of the hazardous waste or a component of the hazardous waste under the proposed operating pressures.

(viii) The locations of other operational or abandoned wells in the area.

(ix) The physical and chemical compatibility between the fluids of the receiving geological formation and the wastes proposed for injection.

(x) Whether the available volume of the receiving geological formation exceeds the proposed volume of wastes to be injected.

(xi) What types of operating difficulties or natural forces could occur.

(3) To fulfill the monitoring requirements of R 299.6409 for injection wells, the owner/operator shall provide for all of the following:

(a) Continuous monitoring and recording of the injection pressure, annulus pressure, flow rate, and cumulative volume of material injected.

(b) Testing of the mechanical integrity of the injection well system at least once every 3 years during the life of the well.

(c) Establishing a monitoring well system to detect any migration of injected wastes into aquifers.

R 299.6428 Land treatment.

Rule 428. (1) Hazardous waste shall not be disposed of at a land treatment facility unless the waste can be made nonhazardous by biological degradation or chemical reactions occurring in or on the soil. The department may require a demonstration that such degradation or reactions will occur under the conditions which will be maintained at the treatment site.

(2) A land treatment facility shall be located, designed, constructed, and operated to accomplish all of the following:

(a) To prevent migration of waste or soils from the point of application of waste.

(b) To minimize runoff from, and surface water ponding on, the active areas.

(c) To prevent migration of hazardous wastes or hazardous waste components into the air.

(d) So that waste is not applied when the surface or subsurface soil is frozen, when the soil is snow-covered, or when the soil is saturated, unless these practices are approved by the department.

(e) So that the pH of the soil in the active portion is maintained between 6.5 and 8.0. This soil pH shall be maintained through the closure and post-closure periods. The department may grant an exemption from this requirement if the applicant demonstrates that the waste will be degraded or chemically altered in conformance with subrule (1) of this rule at the proposed soil pH.

(3) The failure mode assessment shall outline containment and clean-up procedures and schedules which will be implemented if hazardous waste components migrate in the soil below the depth of application or tillage or into the air in quantities which would cause a violation of the act or act 348. These procedures shall be carried out if the monitoring in subrule (5) of this rule shows such migration of hazardous waste components.

(4) Food chain crops shall not be grown on active or formerly active areas. Food chain crops include crops grown for human consumption, crops grown for feed for animals whose products are consumed by humans, and tobacco. The department, in consultation with the Michigan department

of agriculture, may grant an exemption to this subrule if the applicant demonstrates all of the following:

(a) Hazardous components of the waste will not be transferred to the food portion of the crop by plant uptake or direct contact and will not otherwise be ingested by food-chain animals.

(b) Hazardous components of the waste will not occur in statistically greater concentration in the crops grown on the land treatment facility than in the same crops grown on similar but untreated soils nearby.

(c) The land treatment facility will not be operated in violation of the federal resource conservation and recovery act or act 245.

(5) To fulfill the monitoring requirements of R 299.6409 for land treatment facilities, the owner/operator shall provide for all of the following:

(a) The monitoring system shall be based upon the hydrogeological report, the surficial soil types, and the hazardous components of the waste and shall be designed to detect the vertical migration of hazardous components of the waste under the active portions of the land treatment facility and to provide a range of background soil concentrations of hazardous components contained in the waste on similar nearby soils which have not been treated or otherwise contaminated.

(b) At a minimum, the monitoring system shall include soil monitoring using soil cores and soil-pore water monitoring using devices such as lysimeters.

(c) Soil and soil-pore water samples shall be collected below the depth of application or tillage and above the seasonally high water table.

(d) The frequency and timing of soil and soil-pore water sampling shall be based upon all of the following:

(i) The frequency, time, type, and rate of waste application.

(ii) The frequency, time, and rate of precipitation.

(iii) The proximity to groundwater.

(iv) The soil permeability.

(6) The land treatment facility shall be designed, constructed, and operated so that, at the completion of closure, either of the following provisions is complied with:

(a) The soils in the active portion are returned to the background condition determined by the monitoring required in subrule 5(a)(ii) of this rule.

(b) Uncontrolled migration of hazardous components of waste due to leaching, surface runoff, or wind erosion is prevented. To comply with this performance requirement, the closure plan and post-closure maintenance and monitoring plan shall consider the following methods of control in addition to the requirements of R 299.6410 and R 299.6411.

(i) Removal and disposal of all soils contaminated in excess of the range of background concentrations determined by the monitoring required in subrule 5(a)(ii) of this rule. The disposal shall be done in conformance with these rules or with act 641.

(ii) Diversion, collection, and treatment of runoff in conformance with R 299.6405(4) and (5).

(iii) Monitoring of soil and soil-pore water in conformance with subrule (5) of this rule.

(iv) Maintenance of soil pH in conformance with subrule (2)(e) of this rule.

(v) Assurance that growth of food chain crops, including residential gardens, will comply with subrule (4) of this rule.

(7) The owner/operator shall provide for both of the following:

(a) A plan of operation which details management of the site and the waste. At a minimum, this plan shall include all of the following:

(i) Rates and methods of waste application.

(ii) Rates and scheduling of fertilizers and other soil additives.

(iii) Methods and scheduling of tillage.

(b) A vegetative monitoring plan for sites which will produce food chain crops. This monitoring shall provide information which demonstrates compliance with subrule (4) of this rule.

R 299.6429 Consideration of other technologies.

Rule 429. (1) Other methods of hazardous waste disposal not covered in R 299.6415 to R 299.6428 shall be considered on a case-by-case basis.

(2) The owner/operator shall provide sufficient substantiating data to the department to demonstrate that the proposed technology provides an acceptable disposal method for hazardous waste pursuant to the act and these rules.

(3) The department may require the owner/operator to conduct trial tests as necessary to verify that the proposed technology provides an acceptable disposal method.

## Promulgated Pursuant to Act 641, P.A. 1978

## PART 3. SANITARY LANDFILLS

R 299.4301 Licenses and construction permits; new facilities; disposal of inert materials.

Rule 301 (1) As required by section 13(1) of the act, all locations in the state where solid waste is disposed of on land shall have a current license issued by the director, unless exempted by section 18(2) of the act or subrule (3) of this rule.

(2) New facilities shall not be issued an operating license unless the construction permit process specified in sections 10 to 14 of the act and R 299.4303 to R 299.4312 have been complied with.

(3) The disposal of inert materials on land does not require a construction permit or operating license. However, the size and location of disposal sites intended to receive more than 1,000 cubic yards shall be recorded with the solid waste control agency. Additional materials not specifically included as inert in R 299.4103(g) may be designated in writing by the director as inert for disposal at specific sites.

R 299.4302 Existing landfills; review.

Rule 302. (1) Engineering plans, hydrogeologic evaluations, and the surface and groundwater monitoring program for existing sanitary landfills shall be reviewed by the solid waste control agency to assure compliance with these rules. As required by section 14(2) of the act, landfills that are not in compliance with these rules may be issued a timetable or schedule of remedial measures which will lead to compliance within a reasonable time period not extending beyond September 1, 1984.

(2) Landfills which are in compliance with section 14(2) of the act and are located in a county having a population density of less than 50 persons per square mile based on the 1970 census data shall not be required to modify their approved engineering plans to comply with the design standards of R 299.4307 and R 299.4308 so long as the groundwater performance standards of R 299.4306 are met. However, if groundwater does exceed the standards as the result of the operation, the applicant shall bear the responsibility for remedial action.

R 299.4303 Advisory analysis; purpose.

Rule 303. The purposes of the advisory analysis before application is made for a construction permit under section 11(1) of the act are to inform the applicant of other permits which may be required for the proposed landfill, such as air emission and water discharge permits or soil erosion and sedimentation control permits; to provide information on known conditions which may affect the proposed site; and to discuss the application and submission requirements and procedures.

R 299.4304 Construction permits; approval of technical elements required before issuance; construction inspection by registered professional engineer; application package.

Rule 304. (1) Before the issuance of a construction permit, the director shall approve all of the following technical elements:

(a) A hydrogeological report and monitoring program.

(b) An environmental assessment.

(c) An engineering plan.

(2) The applicant shall secure the services of a registered professional engineer to inspect construction of the sanitary landfill. The inspections shall be conducted with such frequency that the engineer may verify compliance with the approved engineering plans. A statement signed and sealed by the registered professional engineer verifying that the construction has proceeded according to the approved plans shall be submitted to the solid waste control agency with the application for an operating license as required by R 299.4313(1).

(3) To provide for completeness and uniformity in the submission of information for a sanitary landfill construction permit, an application package shall be provided by the director which outlines the required maps, calculations, plans, and supportive data necessary for the complete facility design. The design plans for the sanitary landfill shall include topographic maps referenced to United States geological survey datum at a scale of not more than 100 feet to the inch with contour intervals that clearly show the character of the land. These maps and accompanying data shall include, at a minimum, all of the following:

(a) Legal description of property included in the application.

(b) Proposed solid waste boundary.

(c) Borrow areas.

(d) Access roads.

(e) Onsite roads.

(f) Grades for proper drainage of the fill area.

(g) Special drainage devices, if necessary.

(h) Method of stabilizing final cover material.

(i) Fencing.

(j) Structures on the site.

(k) Existing and proposed utilities.

(l) Ultimate site use plan showing possible uses of the completed site.

(m) Airports within 10,000 feet of the property described in subdivision (a) of this subrule.

(n) An explanation of how the sanitary landfill is consistent with the approved solid waste management plan described in part 7 of these rules.

(o) Pertinent information to clearly indicate the soil characteristics and groundwater level.

(p) Method of orderly development, special methods of operation, and final elevations.

(q) Surface water, wetlands, and floodplains within 1,000 feet of the site.

(r) Details of the method of treating or disposing of leachate where applicable.

(4) The environmental assessment required by section 10(2) of the act shall include all of the following:

(a) A description of the existing environment.
(b) The anticipated environmental impact of the proposed action.
(c) Alternatives considered.
(d) Mitigating measures.

(5) Variances to the rules applicable to type III landfills may be granted in writing by the solid waste control agency upon demonstration by the applicant that the requirement in the rules is not feasible and prudent and upon demonstration of either of the following:

(a) The substitute requirement will provide an equivalent degree of protection for the public health and environment.

(b) The public health, welfare, and environment will not be additionally impaired.

R 299.4305 General landfill design; plan preparation; determination of hydrogeological characteristics; groundwater monitor system; groundwater monitor program; surface water monitoring; decomposition gases; diversion and impoundment structures; final grade; grading contours; final cover; side cutoff walls; isolation distances; utilization of floodplains and wetlands; sound levels.

Rule 305. (1) Sanitary landfill design plans shall be prepared pursuant to these rules by a registered professional engineer and shall be sealed as required by act 299. Detailed plans, specifications, and necessary reports shall be submitted in triplicate to the solid waste control agency. Alterations or deviations from these plans shall also be submitted to the solid waste control agency.

(2) The hydrogeological characteristics of the site shall be determined by a study including onsite testing or from earlier reliable survey data to indicate soil conditions, groundwater level, and subsurface charateristics. This study shall follow the rule for conducting hydrogeological evaluations promulgated under act 245, being R 323.2207 to assess the suitability of the site for the proposed sanitary landfill. The study shall include an assessment of existing groundwater quality at the site.

(3) Based on the hydrogeological study prepared pursuant to subrule (2) of this rule, the applicant shall install a monitor system specifically designed to adequately assess the impact of the sanitary landfill on groundwater. A monitor system shall be provided to evaluate groundwater quality at the solid waste boundary as well as at other locations based on the hydrogeological study, considering the local geology, surface water, and groundwater conditions specific to each site. These factors shall determine the number and location of monitor stations. Requirements for the installation shall follow rule for groundwater discharges promulgated under act 245, being R 323.2208.

(4) The applicant shall submit a groundwater monitoring program as part of the application for a construction permit. The program shall, at a minimum, include quarterly monitoring during the active life of the site and biannual monitoring for 5 years following site closure. The department shall have access to the monitor wells for the purpose of obtaining samples.

(5) Surface water monitoring may also be required in addition to groundwater monitoring to assess adequacy of leachate containment and runoff control.

(6) To ensure that methane and other decomposition gases generated within the sanitary landfill do not present a hazard or nuisance to those operating the fill or living and working nearby, a means of assuring that gases cannot travel laterally from the site or accumulate in structures shall be designed and employed.

(7) Diversion or impoundment structures shall be designed and constructed to fully accommodate, and exclude from the active fill area, storm water flows which accompany 25-year, 24-hour, frequency storms. Portions of the landfill which have received final clay or artificial membrane cover shall be graded so as to prevent storm water runoff from entering the active fill area.

(8) Sanitary landfills shall be designed and operated so as to bring the active fill area up to final grade as soon as possible.

(9) To prevent the ponding of water on completed fill surfaces, the grading contours shall tend to forestall development of local depressions due to post construction settlement. Slopes of the final cover shall not exceed 1 vertical on 4 horizontal or as necessary to permit establishment of vegetative cover. The final slope for a type II sanitary landfill shall not be less than 2%. For type II sanitary landfills, the post construction settlement shall be monitored periodically during the 5-year maintenance period and, if necessary, final cover shall be adjusted to compensate for anticipated future settlement.

(10) Final cover shall be a minimum of 2 feet of soil compacted to not less than 90% of maximum dry density as determined by the modified proctor test, ASTM designation D1557-70. The cover material shall also be compacted at a moisture content which is not dryer than 2 percentage points below, nor wetter than 5 percentage points above, optimum moisture content as determined by the modified proctor test. The soil shall have a unified soil classification of ML, SC, CL, or CH, as determined by ASTM method D2487-69. ASTM methods D1557-70 and D2487-69 are incorporated in these rules by reference and are available for inspection at the Lansing office of the department of natural resources. Copies of ASTM procedure D 2487-69 and D1557-70 may be purchased at a cost of $4.00 each, from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103, or from the Department of Natural Resources, Resource Recovery Division, P.O. Box 30028, Lansing, Michigan, 48909, at a cost of $4.00 each. An approved alternative material, when properly sloped and protected, may be substituted for final soil cover if equivalent protection is provided.

(11) Type II natural clay sites where the clay does not extend to the surface shall include side cutoff walls to impede the lateral infiltration of water into the fill and to impede lateral flow of leachate out of the fill interior. A minimum wall width of 10 feet of clay with a permeability of not more than $10^{-7}$ cm/sec is required when there is a possibility of hydraulic head build-up of 5 feet or less outside the wall. Where feasible, gravity dewatering to the natural clay surface shall be employed. A hydraulic head of more than 5 feet shall not be allowed.

(12) Horizontal isolation distances shall comply with the following provisions, as applicable.

(a) The isolation distances established for a specific landfill shall take into consideration immediate and long-term environmental factors, including all of the following:

(i) Noise.
(ii) Blowing papers.
(iii) Dust.
(iv) Odor.
(v) Vectors.
(vi) Pest animals.
(vii) Equipment vibration.

(b) The active work area for new sanitary landfills or expansions to existing sanitary landfills shall not be located closer than 100 feet to adjacent property lines, road rights-of-way, or lakes and perennial streams, or closer than 300 feet to domiciles existing at the time of issuance of a construction permit. In addition, approval of less than 200 feet of isolation distance requires either a berm which is not less than 8 feet high with a 4-foot fence on top and which is constructed around the perimeter of the active work area or natural screening which offers equivalent protection. Greater isolation distances may be required in any of the following situations:

(i) Geological conditions require it.
(ii) The site is adjacent to special quiet zones, as designated by local or state government.
(iii) The site is near an airport.
(iv) Federal or state regulations apply.
(v) Dewatering will adversely affect adjacent aquifers.

(13) A type III sanitary landfill shall not be located within a floodplain or wetland unless the necessity for such a location can be substantiated through an environmental assessment and unless it can be demonstrated that the fill will not affect upstream or downstream flood stages.

(14) A type II sanitary landfill shall not be located within a floodplain or wetland unless it meets all of the following requirements:

(a) The site does not encroach upon the floodway and will not increase upstream or downstream flood stages.

(b) The site meets the criteria of R 299.4307(1)(a).

(c) The location can be substantiated through an environmental assessment which considers alternatives and assures that all potentially negative impacts can be mitigated.

(d) When in the floodplain, the distance from the normal water line of the water body to the landfill will not be less than 500 feet.

(e) The design will include a dike to preclude floodwater inundation with a top elevation not less than 5 feet above the 100-year flood elevation.

(f) Where applicable, the applicant must obtain a permit under Act No. 203 of the Public Acts of 1979, being § 281.701 et seq. of the Michigan Compiled Laws and Act No. 245 of the Public Acts of 1929, as amended, being §323.1 et seq. of the Michigan Compiled Laws.

(15) The applicant shall demonstrate, as part of the permit application, that operation of the proposed sanitary landfill will not result in noise exceeding the following levels for specified adjacent land uses when measured at the common property line nearest the active work area:

| Adjacent use | Maximum sound level |
|---|---|
| Residential. . . . . . . . . . . . . . | 75 dBA. |
| Commercial . . . . . . . . . . . . . . | 85 dBA. |
| Industrial and other . . . . . . . . . | 90 dBA. |

Objectionable noises due to intermittance, beat, frequency, or shrillness shall be muffled so as not to become a nuisance to adjacent uses.

R 299.4306 Groundwater quality performance standard.

Rule 306. (1) The design and siting of sanitary landfills shall insure that groundwater at the solid waste boundary will not exceed standards described in the criteria for classification of solid waste disposal facilities and practices, 40 C.F.R. part 257.3-4 and appendix I of 40 C.F.R. part 257, or that the concentration of substances will not be increased where their existing concentration exceeds the maximum levels established in 40 C.F.R. part 257, appendix I, unless groundwater is unsuitable for human consumption by having greater than 10,000 mg/l total dissolved solids. The provisions of 40 C.F.R. part 257.3-4 and appendix I of such provisions are adopted by reference in these rules. Single copies of 40 C.F.R. part 257.3-4 are available free of charge from the Department of Natural Resources, Resource Recovery Division, P.O. Box 30028, Lansing, Michigan 48909, or from Solid Waste Information, U.S. EPA, 26 West St. Clair Street, Cincinnati, Ohio 45268.

(2) All requirements for the protection of surface and groundwater contained in act 245 and rules promulgated thereunder shall be met.

(3) In the construction permit application, the engineer shall explain the rationale for the design using calculations, if applicable, and professional analyses to show how the proposed design is expected to comply with the performance standard specified in 40 C.F.R. part 257.3-4 and act 245 and the rules promulgated thereunder.

R 299.4307 Type II sanitary landfills; design standards; natural soil sites; lined sites.

Rule 307. (1) The following provisions apply with respect to natural soil sites:

(a) A natural clay base shall have a minimum thickness of 10 feet. The soil shall have a maximum demonstrated permeability of $10^{-7}$ cm/sec and shall meet the criteria for a unified soil classification of SC, ML, CL, or CH. The director may approve a combination of natural clays with a maximum demonstrated permeability of $10^{-6}$ cm/sec having a thickness which provides equivalent protection to the 10 feet of $10^{-7}$ cm/sec soil.

(b) Applications for construction permits for natural soil sites not meeting the permeability or soil classifications of subdivision (a) of this subrule shall be considered based on the hydrogeologic characteristics of the site, including, but not limited to, permeability and thickness of the soils, their ability to attenuate leachate, groundwater level and other factors particular to a specific site. In addition, all of the following requirements apply:

(i) Permeability of the soil shall not exceed $10^{-2}$ cm/sec.

(ii) Forty feet of vertical isolation shall exist between the bottom of the fill and the groundwater level.

(iii) Two thousand feet of lateral isolation shall exist in the direction of groundwater flow measured from the solid waste boundary to properties where domestic wells exist or may be drilled.

(iv) One thousand feet of lateral isolation shall exist in directions lateral to or upgradient of the direction of groundwater flow measured from the solid waste boundary to properties where domestic wells exist or may be drilled.

(v) Based on the hydrogeological evaluation, the director may approve a decrease in the isolation distances specified in paragraphs (ii) to (iv) of this subdivision.

(vi) The proposed facility shall be located within a county having a population density of less than 50 persons per square mile based on 1970 census data and shall not be located within a standard metropolitan statistical area.

(vii) The applicant shall demonstrate by technical calculations, considering the design details and operational procedures specific to the site, how those portions of the landfill which contain solid waste will be kept from becoming saturated to the point that they begin leaching.

(viii) The operational plan shall be designed to bring the active fill area to approved final grade as quickly as possible within the constraints of safe equipment operating practice and efficient use of the land available for disposal.

(ix) Final impermeable cover meeting the specifications of R 299.4305(10) shall be applied to each area as final grade is reached.

(x) Existing licensable sanitary landfills are not available to serve the area or are scheduled for closure within 2 years.

(xi) Sludges from industrial sources and sewage sludge shall be excluded from disposal at the site.

(xii) Sanitary landfills located in soils having a permeability greater than $10^{-4}$ cm/sec shall include as part of the groundwater monitoring program submitted according to R 299.4305(4), quarterly monitoring of wells at the solid waste boundary and at other wells located in the direction of groundwater flow from the active fill area. Parameters to be monitored include pH, COD, and not more than 2 additional parameters, if needed, as determined by the department. If monitoring shows a trend of deteriorating groundwater quality, the department may require monthly monitoring and an increase in the number of parameters.

(xiii) Variances granted under R 299.4108 (5) shall not be effective unless approved by the department.

(xiv) The public notice required by section 11(2) of the act shall indicate that the application is for a "permeable soil sanitary landfill" and that the design and operation of the landfill must comply with special provisions of the rules.

(xv) The solid waste control agency shall conduct quarterly inspections and prepare written reports at all sanitary landfills located in soils having a permeability greater than $10^{-7}$ cm/sec. If an inspection by department staff indicates violations or reasonable cause to believe there may be violations of the act, these rules, or license conditions, the department may require a more frequent inspection schedule.

(2) The following provisions apply with respect to lined sites:

(a) A compacted soil liner shall have a minimum thickness of 3 feet. The soil shall be compacted to a maximum permeability of $10^{-7}$ cm/sec and shall meet the criteria for a unified soil classification of SC, ML, CL, or CH. The soil shall be placed in horizontal lifts uniformly and thoroughly compacted to the standards approved in the design. However, in no case shall the material be compacted to less than 90% of the maximum dry density as determined by the modified Proctor test, ASTM designation D1557-70. The liner material shall also be compacted at a moisture content which is not dryer than 2 percentage points below, nor wetter than 5 percentage points above, optimum moisture content as determined by the modified Proctor test.

To protect the liner and facilitate leachate collection, the surface of the liner shall be covered by a minimum of 1 foot of permeable material meeting the requirements of class II granular material as defined in the publication entitled "Standard Specification for Highway Construction," Michigan department of transportation, or other free draining aggregate approved by the department. This publication is available for inspection at the Lansing office of the department of natural resources and may be purchased at a cost of $9.00 from the Michigan Department of Transportation, P.O. Box 30050, Lansing, Michigan 48909.

(b) Polyvinyl chloride sheeting or equivalent material not less than 20 mils thick and underlain with a minimum of 2 feet of soil compacted to a maximum permeability of $10^{-6}$ cm/sec may be utilized as a liner system. To protect the liner and facilitate leachate collection, the surface of the liner shall be covered by a minimum of 2 feet of permeable material meeting the requirements of class II granular material as defined in the publication entitled "Standard Specification for Highway Construction," Michigan department of transportation, or other free draining aggregate approved by the department. Synthetic liner installation shall be done strictly according to the manufacturer's instructions, unless specifically instructed otherwise by the department. Maximum side slope for synthetic liners is 1 vertical to 2 horizontal.

(c) Polyvinyl chloride sheeting or equivalent material not less than 30 mils thick installed on native soil may be utilized as a liner system. To protect the liner and facilitate leachate collection, the surface of the liner shall be covered by a minimum of 2 feet of permeable material meeting the requirements of class II granular material as defined in the publication entitled "Standard Specification for Highway Construction," Michigan department of transportation, or other free draining aggregate approved by the department. In addition the following requirements apply:

(i) The liner shall be installed strictly according to the manufacturer's instructions, unless specifically instructed otherwise by the department.

(ii) Installation of the liner shall be done under the direct surveillance of the professional engineer.

(d) Other synthetic liner materials and modified soils or technologically advanced liner systems may be utilized based on data supplied by the applicant regarding the system's durability, permeability, resistance to sunlight and chemicals, and performance in similar applications. The director shall determine the acceptability of data and proposed design.

R 299.4308 Leachate collection and treatment.

Rule 308. (1) All type II sanitary landfills, except for those established under provisions of R 299.4307(1)(b) shall have systems to collect and remove leachate and shall be capable of limiting the head at the lowest point in the system to not more than 6 inches.

(2) Leachate removed shall either be reintroduced into the sanitary landfill, if it can be demonstrated that such leachate will be absorbed by the sanitary landfill, or it shall be conveyed to a wastewater treatment facility capable of treating the leachate to meet appropriate discharge standards specified in a wastewater discharge permit issued pursuant to act 245.

R 299.4309 Type III sanitary landfills; design standards; compliance with rules; soil types allowed; testing of wastes.

Rule 309. (1) Type III sanitary landfills shall comply with all parts of these rules not designated as applying to type II sanitary landfills only.

(2) In the construction permit application for type III sanitary landfills, the engineer shall explain the rationale for the design, using calculations, if applicable, and professional analyses, to show how the proposed design is expected to comply with the groundwater quality performance standards of R 299.4306.

(3) In order to be disposed of in a type III sanitary landfill, all wastes, except demolition wastes, trees, and stumps, shall have been subjected to the leaching test protocol specified in R 299.4311 and shall be classed as a type III waste.

R 299.4310 Vertical isolation distances.

Rule 310. (1) Type II natural soil sites meeting the specifications of R 299.4307(1)(a) shall have a permanent minimum clearance of 10 feet from the bottom of the refuse to the groundwater level.

(2) Type II lined sites shall have a minimum clearance of 12 feet from the top of the liner to natural groundwater level or 7 feet from the top of the liner to the permanently depressed groundwater level.

(3) Type III sites shall have a permanent minimum clearance of 4 feet from the bottom of the waste to the groundwater level.

(4) Gravity interception of groundwater to control groundwater level may be utilized. Pumping of groundwater to control groundwater level is not considered permanent and shall not be utilized.

R 299.4311 Leaching tests to classify wastes.

Rule 311. (1) In order to classify waste as appropriate for disposal in a type III landfill, the waste shall be subjected to a leaching test procedure to assist in evaluation of groundwater contamination potential. Where actual field data is available at existing facilities, it shall also be used to assist in the evaluation of groundwater contamination potential.

(2) The leaching test procedure selected shall have been developed by a recognized independent testing association, trade association, professional society, or regulatory agency and shall be documented as to applicability and reproducibility.

(3) The leaching test analytical data, details of the leaching test utilized, and any actual field data available shall be submitted to the department for review and used in the determination of waste classification.

(4) Waste classified as type III waste shall be retested to confirm the classification annually or on a more frequent schedule as may be specified by the solid waste control agency. Tests results shall be submitted to the solid waste control agency.

(5) A waste classified as type III waste may be disposed of in a type II landfill. Other waste may be disposed of in a type II landfill if the waste is not a hazardous waste.

(6) The department may specify that a waste be segregated from other wastes in a type II or type III landfill or that other special handling procedures be used.

R 299.4312 Permeability testing; in cohesive and granular soils.

Rule 312. (1) Permeability testing in cohesive soils shall be determined by the consolidation test according to ASTM procedure D2435-70, AASHTO procedure T216-74, or the falling head permeability test with prior approval by the department.

(2) Permeability in granular soils shall be determined by the constant head permeability test according to ASTM procedure D2434-68, the falling head permeability test, or a field permeability demonstration with prior approval by the department. ASTM procedure D2434-68, ASTM procedure D2435-70, and AASHTO procedure T216-74 are incorporated in these rules by reference and are available for inspection at the Lansing office of the department of natural resources. Copies of the ASTM procedures may be purchased at a cost of $4.00 each from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103, or from the Department of Natural Resources, Resource Recovery Division, P.O. Box 30028, Lansing, Michigan 48909 at a cost of $4.00. AASHTO procedure T216-74 is included in the publication entitled "Standard Specifications for Transportation Material and Methods of Sample and Testing" which may be purchased at a cost of $35.50 from the American Association of State Highway Transportation Officials, Suite 225, 444 North Capitol Street, N.W., Washington, D.C. 20001, or from the Department of Natural Resources, Resource Recovery Division, P.O. Box 30028, Lansing, Michigan 48909 at a cost of $35.50.

R 299.4313 Licensing procedure; construction verification; field notes; application package; inspection by solid waste control agency.

Rule 313. (1) A verification by a registered professional engineer that the construction was in accordance with the approved engineering plan and sealed as required by act 299 shall accompany all license applications. Field notes shall be kept by the verifying engineer and licensee to authenticate compliance with specifications of the engineering plans, the construction permit, and requirements specified in operating licenses. The field notes shall include all of the following items, where applicable:

(a) Dimensions, location, and depth of trenches excavated.

(b) Extent of filled areas.

(c) Extent of areas which have reached final grade.

(d) Extent of areas which have received 2 feet of final cover.

(e) Extent of completed areas which have established vegetation.

(f) Dimensions and location of dikes and liners.

(g) Compaction data for clay dikes and liners.

(h) Construction data with specifics, such as field densities and permeabilities, for dikes and liners.

(i) Location and dimensions of drainage facilities.

(j) Location, elevation, and construction of subsurface drainage facilities.

(k) Elevation of water in monitoring or observation wells (± 0.01 feet for artesian conditions, ± 0.1 for unconfined aquifers).

(l) Groundwater quality of monitoring or observation wells, in quarterly samples.

(m) Installation of gas venting structures.

(n) In subdivisions (a) to (m) of this subrule, all lateral dimensions are to be ± 2 feet.

(o) In subdivisions (a) to (m) of this subrule, except for subdivision (k), all elevations are to be ± 0.5 feet, United States geological survey datum.

(2) The complete license application package shall include all of the following:

(a) The engineering certification.

(b) License application form.

(c) Bond.

(d) License fee.

(e) Restrictive deed covenant.

(f) Field notes. As an alternative to submitting field notes, the engineer may substitute sealed plans showing the information required in subrule (1) of this rule.

(3) The application package shall be submitted to the solid waste control agency.

(4) The solid waste control agency shall make at least 1 inspection of the sanitary landfill following receipt of the license application and shall, before license issuance, evaluate the status of compliance with the act and these rules.

**R 299.4314 Future standards changes; exemption.**

Rule 314. A sanitary landfill which has been issued a construction permit under the act shall not be subject to compliance with changes in the sanitary landfill design requirements of these rules for a period of 6 years after initial licensure of the site if R 299.4306 is not violated.

**R 299.4315 Operating requirements; equipment; supervision; access; unloading of solid waste; control of dust and blowing papers; spreading and compaction; cell volume; hazardous waste, liquids, or sewage; burning;**

onsite roads; salvaging; insects and rodents; sloping, grading, and drainage; noise levels; monitor well sampling; leachate removal and disposal.

Rule 315. (1) Properly maintained equipment of adequate number, type, and size shall be used in operating the sanitary landfill pursuant to established engineering practice and these rules. Backup equipment shall be available on the site or suitable arrangements shall be made to provide for such equipment from other sources during equipment breakdown or during peak loads.

(2) A sanitary landfill operation shall be under the immediate direction of a responsible individual.

(3) Access to a sanitary landfill shall be limited to those times when an attendant is on duty or when an alternative monitoring device is in use and shall be limited to those persons authorized to use the site for the disposal of solid waste. Access to the site shall be controlled by a suitable barrier.

(4) The unloading of solid waste shall be continuously supervised.

(5) Measures shall be provided to control dust and blowing papers. The entire area shall be kept clean and orderly.

(6) Solid waste shall be spread so that it can be compacted in layers of not more than a depth of 2 feet. Large and bulky items, when not excluded from the site, shall be disposed of in a manner approved by the solid waste control agency.

(7) The volume of an individual cell shall not exceed the daily quantity of waste.

(8) Hazardous wastes, liquids, or sewage shall not be disposed of in a sanitary landfill. Materials that would adversely affect the liner shall not be disposed of in a sanitary landfill. This provision does not preclude the right of a sanitary landfill licensee to exclude any materials as a part of his or her operational standards.

(9) The burning of trees, stumps, and brush at a sanitary landfill shall be severely restricted and shall be conducted only in designated areas with the permission of the solid waste control agency and other appropriate authorities. Suitable measures shall be available to extinguish accidental fires.

(10) Onsite roads shall be designed and constructed so that traffic flows smoothly and is not interrupted by ordinary inclement weather.

(11) Salvaging, if allowed by the licensee, shall be organized so that it does not interfere with prompt sanitary disposal of solid waste or create unsightliness or health hazards. Scavenging shall not be permitted. White goods and other recyclable metals may be stored for eventual recycling on site in a separate area away from the active work area if a nuisance or health hazard does not develop. The period of storage shall be stipulated on the license.

(12) Conditions unfavorable to the propagation of insects and rodents shall be maintained by carrying out routine sanitary landfill operations promptly and systematically. Supplemental insect and rodent control measures shall be instituted when necessary.

(13) The entire site, including the fill surface, shall be sloped, graded, and provided with drainage facilities to minimize runoff onto

and into the fill, to prevent erosion or washing of the fill, to drain off rainwater falling on the fill, and to prevent the collection of standing water.

(14) Landfill operations shall be conducted in a manner which will not exceed the noise levels specified in R 299.4305(14). The solid waste control agency shall monitor noise levels using weighted decibel measurements (referenced to 20 micropascals) with a type of audio output meter approved by the United States bureau of standards.

(15) The licensee shall have the monitoring wells sampled at least quarterly during the sanitary landfill's operation. Following the completion of the site, biannual sampling and reporting shall be required during the 5-year maintenance period. Sampling, preservation, and analysis procedures shall be approved by the department. Analyses shall be submitted to the department and the local health department on forms provided by the director.

(16) The licensee shall remove leachate from a leachate collection sump as frequently as necessary to maintain gravity flow in the leachate collection and removal system and shall check the leachate collection sump at least monthly to assure compliance with this requirement.

(17) The collected leachate shall be disposed of in a manner which does not damage the environment. Disposal options may include conveying the leachate to a publicly owned treatment works upon written approval of the municipality operating the treatment works and the department. This rule does not preclude the need for any other authorization required for the leachate disposal method selected.

R 299.4316 Operating requirements; cover material.

Rule 316. (1) A compacted layer of not less than 6 inches of suitable cover material shall be placed on all exposed solid waste by the end of each working day.

(2) One foot of compacted cover, which may include the 6-inch daily cover, shall be placed on the surface of any lift that will be exposed for a period of 3 months or more before additional lifts are constructed.

(3) Landfill cover materials described in R 299.4305(10) shall be placed over the entire surface of each portion of the final lift not more than 3 months following the placement of solid waste within that portion.

(4) Erosion control measures shall be instituted to comply with Act No. 347 of the Public Acts of 1972, as amended, being §282.101 et seq. of the Michigan Compiled Laws, and known as the Michigan soil erosion and sedimentation control act.

(5) All daily cover depths shall be continually maintained. Final cover depths shall be maintained for a period of 5 years.

(6) All final covered areas shall be seeded and stabilized as soon as practical after placement of final cover. Appropriate seed for the soil type, slope, and moisture condition shall be selected for this purpose. Seeded areas shall be inspected regularly by the licensee and measures shall be taken to assure the vegetation is established.

## PART 4. SOLID WASTE PROCESSING PLANTS

R 299.4401 Solid waste processing plants explained; plants handling more than 2 tons per day or 60 tons per month; plants handling less than 2 tons per day or 60 tons per month; plants licensed before effective date of act; food, agricultural, and wood waste.

Rule 401. (1) Solid waste processing plants include those facilities which process solid waste or solid waste in conjunction with liquids for ultimate disposal as a waste or for use as a resource. Solid waste processing plants do not include those facilities which process source separated materials such as glass, cans, and paper for recycling. Both of the following are specifically included as solid waste processing plants:

(a) Incinerators of solid waste.

(b) Facilities processing paper, glass, metals, or other recyclables from a mixture of wastes.

(2) Solid waste processing plants handling 2 tons or more per day or 60 tons or more per month are subject to the provisions of this part, including the requirements for construction permits, operating licenses, and bonding, except for the following specific exemptions:

(a) Scrap dealers processing metal, including waste products of the processing of the metal.

(b) Industrial resource recovery or recycling operations, unless they include disposal of solid wastes from sources outside the individual plant site.

(3) Solid waste processing plants handling less than 2 tons per day or 60 tons per month shall be maintained in a clean and sanitary condition and shall have their location recorded with the solid waste control agency.

(4) Processing plants that were licensed before the effective date of the act are not required to apply for a construction permit, except for facility expansion.

(5) Food processing wastes; agricultural wastes,; and wood wastes; including sawdust, bark, leaves, brush, and wood ashes, may be processed for disposal by land spreading or directly land spread without a requirement for a permit or license under this part or part 3 of these rules. Land spreading of food processing wastes shall be done at agronomic rates and shall include incorporation of the wastes into the soil at the time of land spreading. The solid waste control agency shall be notified of land spreading of food processing wastes.

R 299.4402 Existing processing plants; review.

Rule 402. Engineering plans and monitoring requirements for existing processing plants shall be reviewed by the solid waste control agency to assure compliance with these rules. If found to be deficient, a processing plant may be issued a timetable or schedule of remedial measures which will lead to compliance within a reasonable time period not extending beyond September 1, 1984.

R 299.4403 Advisory analysis; purpose.

Rule 403. The purpose of an advisory analysis before application is made for a construction permit is to inform the applicant of other

# APPENDIX II

## Programs Which Require or May Require Hydrogeologic Investigations

## Programs Which Require or May Require Hydrogeologic Investigations

### I. Programs Under Which Hydrogeological Studies are Required or Prepared

#### A. Water Supply

1. Safe Drinking Water Act, Act 399, Public Acts of 1976

This law, and rules promulgated under the provisions of this law, provide the Michigan Department of Public Health with regulatory supervision and control over public water supplies in Michigan.

Rule R 325.10813 requires the supplier of water of a community and certain large noncommunity systems to furnish the department of public health with a study of hydrogeological conditions for a determination of an isolation area and the acceptability of a proposed location of a well. Suppliers of smaller public supplies must submit hydrogeological investigations if they request modification of the standard isolation area pursuant to Rule R 323.10814.

Rule R 325.10830 requires that each well constructed to serve a public water supply shall be tested for yield or performance prior to putting the well into service.

2. Public Health Code, Act 368, Public Acts of 1978

a. Part 124, Agricultural Labor Camps

Under this part, agricultural labor camps are required to obtain a license for operation from the Michigan Department of Public Health, Division of Community Environmental Health. As part of the licensing program, it is required that the department determine that the camp has an adequate and safe potable water supply. The Safe Drinking Water Act and Rules are used in making this determination.

b. Part 125, Campgrounds

A person proposing to construct, add to, or modify a campground in Michigan must obtain a construction permit from the Michigan Department of Public Health, Division of Community Environmental Health. A person operating a campground in Michigan is required to obtain a license from the Michigan Department of Public Health. The requirements of the Safe Drinking

Water Act and Rules are used in the review of these facilities.

c. Part 127, Well Construction

Under this part, persons engaged in the business of well drilling or pump installing must be registered annually by the Michigan Department of Public Health. It is required by the act that a well drilling contractor shall provide the owner and the Michigan Department of Public Health, or the local health department, with copies of a well log within 60 days after the completion of the well. Included are wells used for domestic water supply, industrial water supply, irrigation wells, and larger dewatering wells.

Provision is made under this part for an advisory board to assist the department in the administration of the act and in the development of rules regarding the construction and installation of water supplies.

d. Part 129, Food Service Sanitation

Food service establishments are required to be licensed annually by the Michigan Department of Public Health. Prior to the construction or remodeling of a food service establishment, construction plans and specifications must be submitted to the local health department or the Michigan Department of Public Health for review and approval. Part of the licensing and construction permit requirements are to assure the existence of an adequate and safe potable water supply. The provisions of the Safe Drinking Water Act are applied to food service establishments.

e. Part 201, Health Facilities and Agencies

The Michigan Department of Public Health, Division of Health Facilities Planning and Construction, is given the regulatory supervision pursuant to this part over the location and construction of health care facilities and agencies in Michigan. Hospitals, nursing homes, homes for the aged, and other types of medical care facilities are included in the definition of health facility. In the review of the water supplies serving these types of facilities, the provisions of the Safe Drinking Water Act are applied. Regulatory authority is provided through the issuance of licenses and certifications of various types.

3. Subdivision Control Act, Act 288, Public Acts of 1967

This act provides for the submittal of a preliminary plat for proposed subdivisions to several agencies, including the local health department and the Michigan Department of Public Health. The health departments have the responsibility of reviewing the plat to assure compliance with the act. The developer must demonstrate that an adequate source of potable water is available to the buyers of lots in the subdivision prior to obtaining approval. This may very well require the submittal of a hydrogeological study, particularly when on-site wastewater disposal is also anticipated, or adjacent properties have discharges which may adversely impact on potable water aquifer.

4. Oil and Gas Act, Public Acts of 1939, Water Flood Operations

The Oil and Gas Section, Geological Survey Division administers this act and may require that an oil or gas well owner be responsible for a hydrogeologic investigation when there is a possibility that water has flooded an oil or gas strata.

5. Mobile Home Commission Act, Act 419, Public Acts of 1976

Act 419 provides for the establishment of the Mobile Home Commission to provide standards for the regulation of the entire field of mobile home living. The standards take the form of a Mobile Home Code made up of rules adopted by the Department of Commerce and by the Department of Public Health. It is required that a person proposing to construct a new mobile home park or modify an existing park must obtain approval of his preliminary plan by four local units of government, including the local health department. Final plans and specifications must be approved by the Michigan Department of Public Health and the Michigan Department of Commerce and a permit to construct obtained from the Department of Commerce. A construction permit issued by the Department of Public Health is required for mobile home park water systems. An annual license for operation must also be obtained from the Department of Commerce based upon its own investigations and inspections conducted by the local and/or state health departments.

6. Local Health Departments, Local Sanitary Codes

Some local health departments have provisions in their county sanitary codes which require construction permits for the installation of wells. The potential exists for local health departments to require a certain amount of hydrogeological information in their approval of the new well site, or a hydrogeological evaluation of the capacity of a new well.

## B. Waste Management and Disposal

### 1. Water Resources Commission Act, Act 245, Public Acts of 1929, as amended

The Water Resources Commission was created by this act and charged with control over pollution of any waters of the state and the Great Lakes, among other responsibilities. Under the provisions of this act, rules have been promulgated by the Commission. Permits are required for the disposal of waste, either through surface water discharge or land disposal. A hydrogeological study must accompany the application for a land disposal permit.

Under the provisions of Act 245, the Water Resources Commission has promulgated surface water quality standards and groundwater quality standards. These groundwater quality standards require the submittal of a hydrogeological study for all new proposals and for all existing dischargers at the time of their permit renewal.

### 2. Municipal Facilities, Act 98, Public Acts of 1913, as amended

Regulatory supervision over the construction and supervision of public sewerage systems is provided the Department of Natural Resources under this act. Construction permits are required from the department for construction or modification of public sewerage systems and operator certification is required. In general, permits are required for public facilities under the provisions of Act 245 for waste discharges. Hydrogeological studies are necessary to justify the issuance of permits and provide design information for land disposal.

### 3. Mobile Home Commission Act, Act 419, Public Acts of 1976

Pursuant to rules adopted under the provisions of this act, the Michigan Department of Public Health must review and approve plans for sanitary facilities serving mobile home parks. Permits under Act 245 are required for waste disposal facilities proposing or using land disposal. A hydrogeological study is necessary upon application for a permit. Small septic tank and subsurface absorption systems may be exempted from this requirement, however a certain amount of hydrogeological information is necessary for all systems.

### 4. Public Health Code, Act 368, Public Acts of 1978

a. Part 124, Agricultural Labor Camps

The Michigan Department of Public Health is provided regulatory responsibility over the development and operation of agricultural labor camps. A certain amount of hydrogeological information may be required for approval of wastewater disposal systems for larger camps. Because of their small size and seasonal nature, the hydrogeological information necessary in most instances is limited to that that can be obtained with a good survey of soil and site conditions.

b. Part 125, Campgrounds

The Michigan Department of Public Health is provided with regulatory supervision over the construction and operation of public and private campgrounds in Michigan. Construction permits are required for new, expanded, or modified campgrounds and annual operating licenses are required. Methods of wastewater disposal other than subsurface soil absorption are required to be authorized under permit issued by the Water Resources Commission under Act 245. A hydrogeological study must accompany the application for such a permit. Certain hydrogeological information is also necessary when waste disposal involves a subsurface soil absorption system.

c. Part 129, Food Service Sanitation

Certain hydrogeological information may be required by the local health department or the Michigan Department of Public Health in their review of the wastewater disposal systems for food service establishments. This may be in connection with new construction or in the investigation of an existing problem.

d. Part 201, Health Facilities or Agencies

Certain hydrogeological information may be required by the local health department or the Michigan Department of Public Health in their review of the wastewater disposal systems serving hospitals, nursing homes, homes for the aged, and other types of medical care facilities. Systems other than subsurface absorption systems require a permit from the Water Resources Commission under Act 245.

5. Liquid Industrial Waste Haulers Act, Act 136, Public Acts of 1969

This Act regulates hauling and control of disposal of liquid industrial wastes. Licensed haulers must not dispose of wastes onto or into the ground except at locations specifically approved by the Emergency Response and Waste Hauler Licensing Section, Department of Natural Resources. No waste is to be placed in a location where it could enter any public or private drain, pond, stream, or other body of surface or groundwater. A hydrogeologic investigation may be prerequisite to disposal site approval.

6. Oil and Gas Act, Act 61, Public Acts of 1939

The Oil and Gas Section, Geological Survey Division is empowered to require the proper disposal of saltwater, brines, and oily waste produced incidental to oil and gas operations by such methods that no unnecessary damage or damages to, or destruction of surface or underground resources to neighboring properties or rights, or to life, shall result. A hydrogeologic investigation may therefore be a prerequisite to permit approval for disposal wells.

7. Mineral Well Act, Act 315, Public Acts of 1969

This act empowers the Mineral Wells Unit, Geological Survey Division, Department of Natural Resources to approve and regulate the use of wells for storage or waste disposal. The well owner is responsible for a hydrogeological investigation involving testing to determine that the well can be used for these purposes and in a manner that will not cause surface or underground waste.

8. Solid Waste Management Act, Act 641, Public Acts of 1978

Application for a construction permit to establish a disposal area must be made to the Resource Recovery Division, Department of Natural Resources through the local health officer. The application must be accompanied by a determination of existing hydrogeological conditions specified in a hydrogeologic report and monitoring program, and by an environmental assessment and an engineering plan. Any alteration of the facility, or expiration of an existing construction permit necessitates a new construction permit as well as submission of additional information the reviewer may require.

This act provides for the promulgation of rules which contain sanitary design and operational standards for solid waste disposal areas. These rules include standards for hydrogeologic investigations and monitoring.

9. Hazardous Waste Management, Act 64, Public Acts of 1979

This act creates a Hazardous Waste Management Planning Committee in the Department of Natural Resources and charges it with the responsibility of developing a statewide hazardous waste management plan. Also provided for in the act is the creation of site approval boards to evaluate the sites for disposal of hazardous waste. Disposal facilities must obtain a construction permit from the director of the Department of Natural Resources. As a part of obtaining this permit, the applicant must have the approval of the site approval board. The board's determination of the suitability of a site shall include an evaluation of the hydrogeological characteristics of the site and shall determine that they are consistent with the rules promulgated by the director for groundwater quality standards.

10. Local Health Departments, Local Sanitary Codes

Local health departments may require hydrogeological information on their review and approval of on-site waste disposal facilities under their local county or district sanitary code. For larger proposals, they may ask for a detailed hydrogeological report.

C. Groundwater Contamination Investigations

1. Water Resources Commission Act, Act 245, Public Acts of 1929, as amended

Pursuant to enforcement actions initiated under this act, a hydrogeological investigation may be ordered to determine the extent of a groundwater contamination incident. The Michigan Department of Public Health may join in the enforcement action and may be involved in the collection and analysis of water samples from affected wells.

2. Toxic Substance Control Commission Act, Act 116, Public Acts of 1978

This act provides for the creation of a State Toxic Substance Control Commission. The purpose of the Commission is to investigate all reports, problems, or irregularities which may involve a toxic substance, in the event that the State agency fails to do so. The Commission may undertake any studies, inquiries, surveys, or analyses, including hydrogeologic investigations, which are relevant to the accomplishment of its purposes, and has the authority to require assistance from a State agency, public institution, or university.

3. Public Health Code, Act 368, Public Acts of 1978

Under Parts 22 and 24 of the Public Health Code, the director of the Michigan Department of Public Health or a local health department, upon a determination that an eminent danger to the health or lives of individuals exist in this state, shall inform affected individuals and shall issue an order requiring such actions as are necessary to eliminate the imminent danger. The director may then take action in the appropriate court to enforce that order. The local health department, under Section 2455, is also provided with the authority to cause the imminent hazard to be corrected on its own action and hold the owner of the premises liable for expenses incurred.

All of these actions may involve a hydrogeological investigation when the incident involves contamination of groundwater.

4. Liquid Industrial Waste Haulers Act, Act 136, Public Acts of 1969

If unlawful pollution of the waters of the State has occurred in connection with the licensed hauling and disposal of liquid industrial waste, the licensee has the responsibility of correcting the problem, a process which may include a hydrogeologic investigation.

5. Oil and Gas act, Act 61, Public Acts of 1939

The Oil and Gas section, Geological Survey Division, Department of Natural Resources is empowered to prevent pollution, damage to, or destruction of fresh water supplies. Upon verified complaint that any of the above has occurred, or is reasonably imminent, the supervisor may take action to determine the validity of the accusation; these actions may include a hydrogeologic investigation to determine the degree and extent of contamination.

6. Mineral Well Act, Act 315, Public Acts of 1969

This act provides for the control of the drilling, operating, abandoning of mineral wells (including test, brine, storage, and disposal wells) to prevent surface and underground waste. The Mineral Wells Unit, Geological Survey Division, Department of Natural Resources may order the prompt correction of any condition or practice found to exist which is causing contamination of surface or groundwater. A hydrogeologic investigation may be deemed necessary by the supervisor to determine the impact of these conditions or practices on the water resources.

D. Surface Water Management

1. Inland Lakes and Streams, Act 346, Public Acts of 1972

Permits are required for the creation, enlargement, or diminution of an inland lake or stream, for structural interference with its natural flow, and for the construction or removal of a structure on bottom land. Upon receiving a permit application, the Land Resource Programs Division, Department of Natural Resources must consider the possible effects of the proposed action upon the inland lake or stream, and upon ground and surface waters from which or into which its waters flow. A hydrogeologic investigation may be necessary to make this evaluation, and is the responsibility of the permit applicant.

2. Great Lakes Submerged Lands, Act 247, Public Acts of 1955

This act gives power to the Land Resource Programs Division, Department of Natural Resources to regulate the lake bottoms and made lands in the Great Lakes of Michigan. Permits must be obtained to fill in any submerged lands, for permanent improvements to or construction of structures on submerged lands, or to connect any natural or artificially constructed waterway with any of the Great Lakes. Application for the permit may require a hydrogeologic investigation to determine the impact of the proposed action on the ground and surface waters of the area.

3. Construction of Dams in Streams, Act 184, Public Acts of 1963

Approval of the Water Management Division, Department of Natural Resources must be obtained prior to the erection of dams in streams or rivers. This approval may be contingent upon results of a hydrogeologic investigation.

E. Primarily State Conducted

1. Engineering Division, Department of Natural Resources

During the design of certain state facilities such as state parks and campgrounds, fish hatcheries, and other Department of Natural Resources facilities, the Engineering Division may perform, or contract to be performed, hydrogeological investigations in connection with either water supply or sewage disposal.

2. Department of Management and Budget

In connection with the design or modification of certain state-owned facilities such as correction facilities, state-owned office buildings, etc., the Department of Management and Budget may contract for the preparation of a hydrogeological investigation in connection with water supply or sewage disposal facilities.

## F. Department of Transportation

In connection with the construction of state highways and associated facilities such as rest areas, borrow pits, and salt storage facilities, the Department of Transportation may conduct, or contract to be conducted, hydrogeological investigations in regard to various aspects of construction or water supply, wastewater disposal, or drainage and groundwater protection. It may also be necessary that hydrogeological investigations be conducted in connection with the preparation of environmental impact statements for new or modified highway construction.